

THE PHILIPPINE AGRICULTURIST

JOURNAL OF THE COLLEGE OF AGRICULTURE
AND CENTRAL EXPERIMENT STATION
University of the Philippines

CONTENTS

- The Effect of Source of Seed on the
Performance of Philippine Corn
Hybrids P. C. Javier
and F. A. Aquilizan 429
- Corn Fertilization and Seed Quality ... Jorge G. Davide 433
- A Preliminary Study on the Effects
of White Corn in the Ration for
Gestating Sows and their Vitamin
A Requirement J. A. Eusebio,
A. B. Lopez, E. C. Cruz,
B. F. Llorico, and
R. B. Puyaoan 439
- The Feeding Value of Corn Gluten
Feed in Rations for Lactating
Dairy Cows and Growing Dairy
Heifers L. L. Clamohoy,
L. E. Nazareno, J. S.
Bontuyan, and
P. L. Ordinario 453
- The Effect of Bone Meal in Ration
for Growing Dairy Cattle and
Murrah Carabaos T. A. Dulay, C. B. Perez,
Jr., B. B. Ramin, and
L. L. Clamohoy 461
- Biosynthesis of C^{14} —Labeled Coco-
nut Meat: 1. Incorporation of
 $NaHC^{14}O_3$ A. R. Carangal, Jr.
and C. R. Baril 472
- NOTES:
1. The Influence of Nitrogen
and Phosphorus Nutrition on the
Flowering Behavior of Rice ... Ernesto B. Pantastico 474
2. Ascorbic Acid Contents of
Some Philippine Fruits Mamerta M. Ylagan 477

UNIVERSITY OF THE PHILIPPINES PUBLICATIONS SERIES A
Published at College, Laguna



The Philippine Agriculturist

Journal of the College of Agriculture and Central Experiment Station
University of the Philippines

EDITORIAL STAFF

FAUSTINO T. ORILLO, Editor
ROGELIO D. FELICIANO, Acting Associate Editor
THOMAS G. FLORES, Business Manager
SILVERIO M. CENDAÑA, Animal Sciences
NICOLAS L. GALVEZ, Physical Sciences
PEDRO B. ESCURO, Plant Sciences
GIL F. SAGUIGUIT, Social Sciences
SANTIAGO M. ALVIAR, Statistics

ADMINISTRATIVE STAFF

DIOSCORO L. UMALI Dean
ANDRES P. AGLIBUT Director of Business Affairs
GIL F. SAGUIGUIT Director of Instruction
FAUSTINO T. ORILLO Director of Research
JOSE M. CAPINPIN Head, Department of Agricultural Botany
LEOPOLDO J. VILLANUEVA Head, Department of Agricultural Chemistry
EMILIO U. QUINTANA Head, Department of Agricultural Economics
MARTIN V. JARMIN Head, Department of Agricultural Education
DANTE B. DE PADUA Head, Department of Agricultural Engineering
PEDRO B. ESCURO Head, Department of Agronomy
GONZALO V. GARCIA Head, Department of Animal Husbandry
CLEMENCIO Q. PEÑA In Charge, Department of Entomology
AMPARO G. RIGOR In Charge, Department of Home Technology
EDELWINA C. LEGASPI Head, Department of Languages
VICTORIA M. ELA Head, Department of Plant Pathology
JORGE G. DAVIDE Head, Department of Soils

THE PHILIPPINE AGRICULTURIST is published monthly except in April and May by the College of Agriculture and Central Experiment Station, University of the Philippines, College, Laguna. The subscription price is ₱6.00 a year in the Philippines and \$4.00 (U.S. Currency) elsewhere; the price of single copies, ₱0.75 in the Philippines and \$0.50 elsewhere.

Authors of articles appearing in THE PHILIPPINE AGRICULTURIST are severally responsible for the opinions expressed therein.

Publications sent in exchange for THE PHILIPPINE AGRICULTURIST should be addressed to the Library of the College of Agriculture and Central Experiment Station, University of the Philippines.

Entered at the Post Office at College, Laguna, Philippines, as second-class mail matter

THE EFFECT OF SOURCE OF SEED ON THE PERFORMANCE OF PHILIPPINE CORN HYBRIDS

P. C. JAVIER and F. A. AQUILIZAN

Philippine Hybrid Nos. 3 and 7 produced by private cooperators in two different towns of Laguna were compared with corresponding hybrids produced in the U.P. College of Agriculture. No significant differences in yield, plant and ear heights, and shelling percentage were noted. These results indicated that a good job of field certification, which includes checking of detasseling operations, was performed in these two seed farms by the field inspectors.

The production of hybrid corn seed in the Philippines has been delegated to qualified private cooperators approved by the Seed Board. Certification is the best and only practical method of insuring production of high-quality seeds of the desired genetic identity and level of purity. It seems to it that the seed is really what it represents, that the parental stocks used are pure and true to type, that provisions for thorough crossing in isolation are made, and that the seed passed laboratory testing for germination and visible purity. But in spite of this assurance of quality of the seed, most farmers, especially the less-informed ones, are reluctant to buy seed from cooperators. They still ask the question: "Is the performance of hybrid corn seed produced by cooperators equal to that of the hybrid seed produced in the U.P. College of Agriculture?"

Obviously, the best way to answer this question is to produce hybrid seeds in cooperators' farms and compare these with corresponding hybrids produced in the College of Agriculture. For a valid comparison, the same parental stocks must be used.

This study was made in the Central Experiment Station and in the Plant Breeding laboratory of the Department of Agronomy, U.P. College of Agriculture, during the 1957-58 dry season.

MATERIALS AND METHODS

Planting materials. The planting materials used were Philippine Hybrid Nos. 3 and 7, and College Yellow Flint. Philippine

¹ Central Experiment Station Contribution No. 2067.

Hybrid No. 3, (A102 $\times$ A106) (A112 $\times$ A113), was obtained from the San Miguel Brewery farm in Calauan, Laguna and Philippine Hybrid No. 7, (I18 $\times$ I80) (A102 $\times$ A106), from Dr. Dionisio Hocson's farm in Biñan, Laguna. The corresponding hybrids and the varietal check were obtained from the Division of Plant Breeding.

Field plot design. The simple randomized complete-block design with four replications was used. Each plot was composed of 2 rows, 1 meter apart; each row had 10 hills, 1 meter apart.

Planting. The hybrids and the check were planted on October 20, 1957. Five kernels were planted to a hill and after three weeks, these were thinned to 3 plants per hill. Guard rows were provided around the experimental area.

Field observations. At tasseling time, observations on the following were made: (a) height of ear from ground, (b) height of plants, and (c) resistance to insect pests and diseases.

Data taken after harvest. Ears were harvested clean of husk and dried to about 15 per cent moisture using a forced-hot-air "Habco" dryer before the shelling percentages and grain yields were determined. Yields were expressed in cavans (54 kilograms) per hectare at 15 per cent moisture (table 1).

TABLE 1.—Grain yield in cavans per hectare at 15 per cent moisture of the hybrids and the check variety.

RANK	ENTRY	BLOCKS				ENTRY MEAN	EXCESS OVER OVF
		I	II	III	IV		
1	College Philippine Hybrid #7	66.5	72.3	72.7	65.2	69.2	31.8
2	Dr. Hocson's Phil. Hybrid #7	66.4	62.8	70.2	63.7	65.8	28.4
3	College Phil. Hybrid #3b	61.8	58.8	64.4	59.0	61.0	23.6
4	SMB Phil. Hybrid #3b	58.8	56.6	60.7	65.6	60.4	23.0
5	College Yellow Flint (check)	30.1	40.5	39.7	39.2	37.4	0
Mean		56.7	58.2	61.5	58.5	58.8	

RESULTS AND DISCUSSION

Yield. No significant differences were noted between the yields of the hybrids produced in College and the corresponding hybrids produced in the cooperators' farms. It is interesting to note that the hybrids produced in the three different locations significantly outyielded College Yellow Flint, the check, at the one per cent level.

Analysis of Variance

SOURCE OF VARIATION	DF	MEAN SQUARE	COMPUTED F VALUE
Entries (E)	4	622.79 ^a	48.66
Blocks (B)	3	20.42	1.60
Entries × Blocks, Error	12	12.80	
Total	19		

^a Highly significant.

CV = 6.09 per cent.

HSD 0.05 = 8.1 cavans

0.01 = 10.4 cavans

The increase in yield of the hybrids over the yield of the check ranged from 61.5 to 85.0 per cent. College produced Philippine Hybrid No. 7 significantly outyielded both College-produced Philippine Hybrid No. 3 and SMB-produced Philippine Hybrid No. 3.

Other observations. In addition to yield, the other agronomic characters of the experimental plants were taken (table 2). The data were all analyzed and differences were found to be non-significant.

TABLE 2.—Mean plant and ear heights and shelling percentage of the hybrids and the check

ENTRY	HEIGHT (cm.)		SHELLING PERCENTAGE
	Plant	Ear	
College Hybrid No. 3	224	95	82.7
SMB Hybrid No. 3	231	99	82.9
Dr. Hocson's Hybrid No. 7	233	97	82.5
College Hybrid No. 7	233	105	82.7
College Yellow Flint ^a	210	84	82.5

^a Check variety.

Rust (*Puccinia polysora* Underw.) severely infected all entries. Slight damages due to the stalk borer, ear worm, and kernel blast were also noted.

Stand was very good; no stalk and root-lodging occurred.

Snedecor ² stated that accurate corn variety trials often have coefficients of variation between 5 and 15 per cent. The coefficient of variation of this study was 6.1 per cent, a very acceptable value,

² J. W. Snedecor, "Statistical Methods," 4th ed., Iowa, The Iowa State College Press, 1946, 534 pp.

indicating that the results obtained in this experiment were very reliable.

As expected, the performance of adapted corn hybrids was not affected by the source of the seed and the conditions under which the seed was produced. This is in accord with the findings of Kiesselbach (1937)³ who attributed it to "the essential purity of the inbred parents and to official state inspection and certification." In other words, the performance of a particular double-cross corn hybrid is primarily due to the inbred lines that compose it. Whatever effect environment has on the seed must have been very minute, or it should have been recognized easily. It is believed, however, that drought, over-abundance of water, nutrient-deficient soils, immaturity, and other factors that affect the seed parent of the hybrid may consequently influence the performance of the corn crop.

Inasmuch as the source of seed seems to have no appreciable effect on the yield and other agronomic-characters of a double-cross hybrid corn, farmers may be advised to buy certified seed from any authorized seed producer with confidence that his crop will excel in performance and is comparable to the hybrid produced in the College of Agriculture.

³ T. A. Kiesselbach, *Nebraska Bull.* 305 (1947).

CORN FERTILIZATION AND SEED QUALITY ¹

JORGE G. DAVIDE ²

Fertilization increased corn yield significantly. The yield response, however, was due to nitrogen alone. In addition to the yield response, fertilization resulted in increased ear-size, ear- and seed-weight. While the effect of phosphorus was not shown in the yield, ear-size and seed-weight were greatly affected by phosphorus and nitrogen application. This was taken as evidence that for commercial seed production, fertilization with nitrogen and phosphorus is necessary.

Corn yields can be markedly increased by the proper use of fertilizers. In order to produce a high yielding crop of corn, large amounts of nitrogen, phosphorus, and potassium are required. About half or more of the total nitrogen required by corn has to be supplied through fertilizers (Krantz and Chandler, 1949; Scarseth, *et al.* 1943).

Experiments of the Department of Soils, U.P. College of Agriculture showed that a corn crop yielding an average of 41 cavans of shelled corn per hectare (1 cavan = 54.06 kg.) would remove about 70, 19, and 39 kg. of nitrogen, phosphorus, and potassium, respectively. Viets and Domingo (1948), Kohnke and Vestal (1948), and Galvez *et al.* (1956) reported that the nitrogen content of corn grain could be greatly increased through nitrogen fertilization. Corn of different protein levels could be produced by varying the nitrogen level of the soil through fertilization or by growing corn in soils of different fertility levels. In addition to increased quantity of protein, the protein quality is also influenced by fertilization. Sauberlich *et al.* (1953) as cited by Nelson (1956), compared samples of corn grains from plots receiving 24 lbs. N per acre with those receiving 84 lbs. N per acre. The protein content for the low-N treatment averaged 7.5 per cent while for the high-N treatment, 10.7 per cent. The high rate of nitrogen resulted in a marked increase in the content of all 18 amino acids when expressed as a percentage of a given amino acid in the whole corn grain. Prince (1954) found that increasing the

¹ Central Experiment Station Contribution No. 2068.

² The author wishes to express his thanks to Messrs. I. T. Corpuz, G. V. Simsiman, and S. N. Tilo, all of the Department of Soils, for the help they have extended.

rate of nitrogen increased the total proteins, the zein fraction, and leucine in the corn grain. Increasing the plant population decreased the percentage of crude protein, zein, and leucine. The zein content is usually higher in corn grown under high soil nitrogen than under low nitrogen (Schneider *et al.*, 1952).

Galvez *et al.* (1956) found that the nitrogen accumulation in the corn grains was significantly influenced by nitrogen levels. The tendency was for the nitrogen concentration in the grain to increase as rate of nitrogen application increased. Over all nitrogen levels, different hybrids and varieties varied in their nitrogen uptake or accumulation. Phosphorus accumulation in the grain was also affected by nitrogen fertilization. There was, however, a significant interaction between nitrogen fertilization and hybrid or variety on phosphorus accumulation. This shows that these hybrids or varieties accumulate phosphorus differentially at various nitrogen levels.

One of the agronomic practices recommended in corn production is seed selection. The criteria for a good seed may be viability and size or plumpness of the grain. Seed germination is a metabolic process and the substrates for the various enzymatic reactions occurring within the seed during germination are the stored foods. The quality of the grain produced influences to some extent the percentage of germination.

The purpose of the investigation reported here was to determine the effect of fertilization on the quantity and quality of seed or grains produced.

MATERIALS AND METHODS

The data used in this work were obtained from the continuous corn cropping experiments of the Department of Soils. The fertilizer treatments shown in table 1 were replicated four times. Hybrid corn (Philippine Hybrid No. 3) was planted at a distance of one meter between rows and one-half meter between hills. About a week after germination, the stands were thinned down to two plants per hill to obtain a plant population of 40,000 per hectare. One-half of the total nitrogen required and all of the phosphorus and potassium were drilled in the rows at planting. The rest of the nitrogen was side-dressed after 5 weeks.

The experiment was conducted on a Lipa clay loam soil at the College of Agriculture and Central Experiment Station. This soil

has a pH of 5.8, organic matter content of 2.1 per cent, available phosphorus of 20.3 ppm, and potassium of 137 ppm.

The responses to fertilization were measured in terms of yields in cavans per hectare, ear-size as determined by the length of the grain-filled ear, circumference at the greatest girth, weight of a given number of grains, and the weight per unit volume of grains. These characteristics were used as criteria for seed quality. From each plot, 10 representative ear samples were shelled. The grain weights were obtained by weighing four 200-grain samples from each plot. To obtain the volume-weight, a tared aluminum-can container of known volume was filled with grain and then weighed.

RESULTS AND DISCUSSION

Yield. The influence of fertilization on the yield of corn is presented in table 1.

TABLE 1.—*Effect of increasing rates of nitrogen upon the yield of corn*

FERTILIZER TREATMENTS	MEAN YIELD
kg./ha.	cav./ha. ^a
Check	28.2
45 N	57.4
45 N + 30 P ₂ O ₅	61.3
90 N	72.7
L.S.D. (.05)	7.6
L.S.D. (.01)	11.0

^a 14 per cent moisture.

The above data show a very marked response to nitrogen fertilization. Previous yield data from the same field did not show phosphorus and potassium response. The addition of 45 kg. nitrogen per hectare increased the yield by more than 100 per cent. Moreover, the increase in yield beyond the 45-kg. rate was still significant.

Ear size. At a constant population density and at any given fertility level, high yields are reflected by ear-size. Table 2 shows the relationship of soil fertility levels and the length and circumference of the grain-filled ears.

The ear-size in terms of the above parameters was greatly increased by fertilization. Short and thin ears are associated with low

yield (table 1) which in turn is associated with low fertility levels. While the yield data show a response only to nitrogen, the ear-size data, however, indicate that the addition of phosphorus enhances production of bigger ears. It may be noted further that fertilization or increasing the fertility level of the soil resulted in the production of heavy ears.

TABLE 2.—*Effect of fertilization on ear length and circumference*

TREATMENT	AVERAGE LENGTH	AVERAGE CIRCUMFERENCE	AVERAGE WEIGHT PER EAR ^a
kg./ha.	cm.	cm.	gms.
0	8.4	12.0	51.0
45 N	11.4	13.2	97.5
45 N + 30 P ₂ O ₅	12.3	13.4	102.5
90 N	13.8	14.1	107.0
L.S.D. (.05)	0.6	0.4	17.5
L.S.D. (.01)	1.1	0.6	25.2

^a Data obtained from another experiment. P₂O₅ rate was 90 kg./ha.

Grain weight. The effects of fertilization on the grain weight, weight per grain, and volume-weight are given in table 3.

TABLE 3.—*Influence of fertilizer on grain weight, weight per grain, and volume-weight*

TREATMENT	AVERAGE WEIGHT	AVERAGE WEIGHT PER GRAIN	AVERAGE VOLUME-WEIGHT
kg./ha.	gms.	gms.	gms./cc.
0	38.28	.187	0.8962
45 N	40.24	.201	0.9036
45 N + 30 P ₂ O ₅	47.14	.235	0.9093
90 N	44.97	.225	0.9085
L.S.D. (.05)	2.93	.016	.0075
L.S.D. (.01)	4.21	.023	.0107

The data in the second column represent the mean weight of sixteen 200-grain samples. The increase in weight due to the application of 45 kg. N/ha. was not significant. It required about 90 kg. N/ha. before a weight response was obtained. This relationship was also true with the weight per grain. However, heavier grains were obtained even at the low nitrogen level as long as phosphorus was applied in combination with nitrogen. It is interesting to note

that the effect of phosphorus on the weight per grain was rather marked although phosphate response was not shown in the yield.

In selecting seeds for planting purposes, choice is made on big-sized and plump seeds. One would expect that under normal conditions for germination, bigger seeds which have more stored foods or substrates for metabolic processes involved in germination give healthy and more vigorous seedlings than small-sized grains. Hence, better and uniform stand is insured with good seeds assuming, of course, that other factors are not limiting. The data presented above provide evidence that fertilization, especially with enough nitrogen and phosphorus, is necessary to insure good seed production.

The volume-weight of the grain refers to the weight of grains occupying a unit volume. This seed property is a further measure or an indication of seed size and/or seed weight. The effect of fertilization especially of nitrogen and phosphorus follows a similar trend as the weight per grain. The effect of 90 kg. N alone was comparable to the effect of 45 kg. N in combination with 30 kg. P_2O_5 .

SUMMARY AND CONCLUSION

The effect of fertilization on corn yield and quality of grain for seed production was investigated.

Corn yields were greatly increased by nitrogen fertilization. Phosphorus response was not shown.

The quality of seed corn produced was improved by the use of fertilizer. While yield response did not reveal the effect of phosphorus, ear-sizes, and seed weights were increased by phosphate application. The evidence presented indicate that for quality seed production, fertilization with nitrogen and phosphorus is necessary.

LITERATURE CITED

- GALVEZ, N. L., E. A. OCHAVILLO, F. S. MELODIA, N. C. BRADY, I. T. CORPUZ, N. B. NAZARENO, and A. B. LOPEZ. 1956. The effect of different rates of nitrogen on the yield and chemical composition of corn. *Philippine Agriculturist* **40**: 104-114.
- KOHNKE, H. and C. M. VESTAL. 1948. The effect of nitrogen fertilization on the feeding value of corn. *Soil Sci. Soc. Amer. Proc.* **13**: 299-302.
- KRANTZ, B. A. and W. V. CHANDLER. 1949. Fertilize corn for higher yields. *North Carolina Agric. Expt. Sta. Bul.* 366.

- NELSON, L. B. 1956. The mineral nutrition of corn as related to its growth and culture. *Adv. in Agron.* **8**: 321-375.
- PRINCE, A. B. 1954. Effects of nitrogen fertilization, plant spacing, and variety on the protein composition of corn. *Agron. Jour.* **46**: 185-186.
- SCARSETH, G. D., H. L. COOK, B. A. KRANTZ, and A. J. OHLROGGE. 1943. How to fertilize corn effectively in Indiana. *Purdue Univ. Agric. Expt. Sta. Bul.* 482.
- SCHNEIDER, E. O., E. B. EARLEY, and E. E. DETURK. 1952. Nitrogen fractions of the component parts of the corn kernel as affected by selection and soil nitrogen. *Agron. Jour.* **44**: 161-169.
- VIETS, F. G., JR. and C. E. DOMINGO. 1948. Yield and nitrogen content of corn hybrids as affected by nitrogen supply. *Soil Sci. Soc. Amer. Proc.* **13**: 303-306.

A PRELIMINARY STUDY ON THE EFFECTS OF WHITE CORN IN THE RATION FOR GESTATING SOWS AND THEIR VITAMIN A REQUIREMENT¹

J. A. EUSEBIO, A. B. LOPEZ, E. C. CRUZ, B. F. LLORICO, and
R. B. PUYAOAN

WITH SIX TEXT FIGURES

Three preliminary experiments involving 10 sows and 83 baby pigs were carried out to study the effect of white corn in the ration for gestating sows. They were also designed to determine the vitamin A requirement of pregnant sows. Several criteria of adequacy were investigated and their sensitivity and validity were described. These criteria were plasma vitamin A, weight gain and liver vitamin A. Gross anatomy of the cerebrospinal vertebrae was examined in abnormal cases to study the possible physiological cause.

A regression response line was evolved in studying the relationship of the dietary vitamin A level for gestating sows and the liver stored in baby pigs at birth.

One of the white corn-fed sows gave birth to a dead and blind litter after 128 days of pregnancy.

The minimum vitamin A requirement for pregnant sows was approximately 12,180 I.U. per kilogram feed. The best result was obtained with the supplementation of 4.5 per cent ipil-ipil leaf meal to white corn, the calculated dietary vitamin A level being 15,548 I.U. per kilogram.

The 6 per cent ipil-ipil leaf meal supplement produced depressed growth rate, diarrhea, and rough hair coat in baby pigs.

Yellow corn, rich in vitamin A because of its beta-carotene and closely related cryptoxanthin, is used in all swine rations. White corn is cheaper but poor in vitamin A.

Experiments have shown that a severe lack of vitamin A in the diet for gestating females resulted in fetal resorption or growth retardation in the young, or, according to Hale (1933), in congenital malformations of soft tissues, such as pigs born without eyeballs. Frape (1956) said that females required more vitamin A to maintain a normal estrous cycle, length of reproductive life, and

¹ Central Experiment Station Contribution No. 2069.

number of young born and reared, than to maintain their normal good health.

Braude *et al.* (1941) considered 100 I.U. of vitamin A per 10 pounds liveweight daily as the minimum requirement of pigs from 8 weeks and older. Likewise, Hentges *et al.* (1952) determined the need of the pig of about the same age for the purified source of carotene to be 25 ug. per kilogram body weight per day, which however, resulted in some liver storage of vitamin A.

Three experiments involving 10 Duroc Jersey, 2 Berkshire gilts, and 83 baby pigs, were undertaken to study: (a) the effect of substituting white corn for yellow corn during gestation and lactation, (b) the effect of ipil-ipil leaf meal at varying levels in rations containing white corn, and (c) the nutritional abnormalities in baby pigs as well as in sows, and (d) the vitamin A requirement of gestating sows under local conditions.

The responses to the rations were measured by blood plasma and liver vitamin A levels (both in the dam and litter), recovery of vitamin A in the chick liver (assay), weight gains, thoracic canal and gross appearance of abnormalities.

MATERIALS AND METHODS

Prior to the start of the feeding experiment, the 10 Duroc gilts, ranging from 7 to 8 months old, were fed the gilt developer ration (containing 7,076 I.U. of vitamin A per kilogram) shortly before breeding until they were positively gravid. These gilts were randomly allotted into five treatments and naturally bred by the same boar as they came in heat. However, the original Durocs in Lot IV which failed to conceive after several breedings were replaced by the Berkshire gilts.

Experiment 1. Two gilts were confined in each pen and fed the corresponding ration (table 1) during the gestation period. One week before farrowing, the sows were placed individually in farrowing pens until the litters were weaned.

Blood plasma vitamin A was determined in each gilt at breeding time and at farrowing by the Kimble calorimetric method (1939). The blood was drawn by cutting the coccygeal vertebrae (about the Cg 23) with a sharp scissor about 1½ centimeters from the tip of the tail as the initial blood plasma vitamin A reading. Blood sample

was also taken at farrowing from the posterior auricular vein behind the ear. The blood was immediately centrifuged to obtain the plasma which was stored at 4°C until analysis was made.

TABLE 1.—Composition of experimental rations

INGREDIENTS	EXPERIMENTAL LOTS				
	I	II	III	IV	V
Fine rice bran	35	33.5	32	30.5	29
Ground white corn	30	30	30	30	30
Fish meal	3	3	3	3	3
Soybean oil meal (Solvent)	3	3	3	3	3
Ground copra meal	12	12	12	12	12
Corn gluten feed	14	14	14	14	14
Ipil-ipil leaf meal	—	1.5	3	4.5	6
Molasses	3	3	3	3	3
Minerals					
Ground oyster shell	1	1	1	1	1
Salt (Iodized)	1	1	1	1	1
Calculated Analysis					
Protein, %	16.46	16.55	16.63	16.71	16.82
Vitamin A, I.U./Kg.	6.16	5,187.0	10,367.0	15,548.0	20,729.0
Energy, Cal./Kg.	1,795.0	1,800.0	1,803.0	1,807.0	1,810.0

Experiment 2. The dietary levels for vitamin A in the rations were adjusted by the addition of ipil-ipil leaf meal (*Leucaena glauca* Linn). Levels of ipil-ipil leaf meal in white corn ration were 1.5, 3.0, 4.5, and 6.0 per cent. The basal ration which served as control also contained vitamin A because of the corn gluten feed. However, this dietary level is low compared to the nutritional requirement of pregnant sows (U.S. National Research Council, 1959).

To obtain liver samples for vitamin A analysis, two newly-born pigs in each treatment were sacrificed. Biopsy by laparotomy was not possible because of the lack of facilities; besides, the pigs were newly born. Approximately 2.5 grams of sample was taken from the liver of each pig. The remaining portion of the liver was vacuum dried, fed to depleted chicks, and determined for vitamin A recovery in the chick liver. The liver vitamin A stored in the pig and in the chick was determined by the method of the Association of Vitamin Chemists (1951).

Chick Assay. Because of the non-availability of laboratory rats for vitamin A assay, chicks were used. Padgett and Ivey (1959)

successfully used quail as a laboratory animal. Four groups of five White Leghorn chicks in each group (2-5 days old) were depleted by feeding them with vitamin A-deficient diet (table 2) for 30 days, until characteristic symptoms of vitamin A deficiency showed. After the depletion, two groups of chicks were fed with dried liver obtained from two treatments: the basal or 6.16, and 1.5 per cent level or 5,187 I.U. of vitamin A per kilogram. The other two groups of depleted chicks served as the negative and positive references. The positive reference group was fed with cod-liver oil containing not less than 850 U.S.P.

TABLE 2.—*Chick vitamin A deficient diet*

INGREDIENTS	PARTS BY WEIGHT
Fish meal	1.8
Yeast, dried	1.8
Starch	13.0
Vegetable oil	1.0
Rice bran	1.8
Salt	0.6
Total	20.0

The remaining pigs from the litters of the different treatments were raised up to weaning. In testing for the differential growth performance, the average daily gains and not the total gain were considered because of different weaning times ranging from 40 to 52 days among the various treatments. The computation for statistical measures was simplified by multiplying the values of gain by 100 to reduce the decimal places.

All the pigs in the experiment received the same care and management. Heat lamps were provided during lactation time until weaning.

Experiment 3. The general health conditions of both the litter and dam were observed for nutritional abnormalities. Percentage mortality was recorded. The gross anatomy of the vertebrae in abnormal and normal pigs were compared. The thoracic vertebrae of the newborn pigs sacrificed were fixed in a 3.7 per cent formalin solution for two days and then dried under the infra-red lamp for three minutes, taking care not to burn the bones. The width and height of the spinal canal (thoracic) were measured with a vernier caliper.

RESULTS

Vitamin A recovery in blood plasma. The gestation rations with varying levels of ipil-ipil leaf meal produced a marked effect on the vitamin A in the blood plasma of the sow at farrowing. The influence on the vitamin A content of the blood plasma of the sows fed 1.5 per cent, as compared to the basal, was obvious; that of Lot III receiving 3.0 per cent, as compared to Lot IV (4.5), was much less obvious. The trends of the depletion from the initial blood plasma vitamin A are illustrated in figure 1.

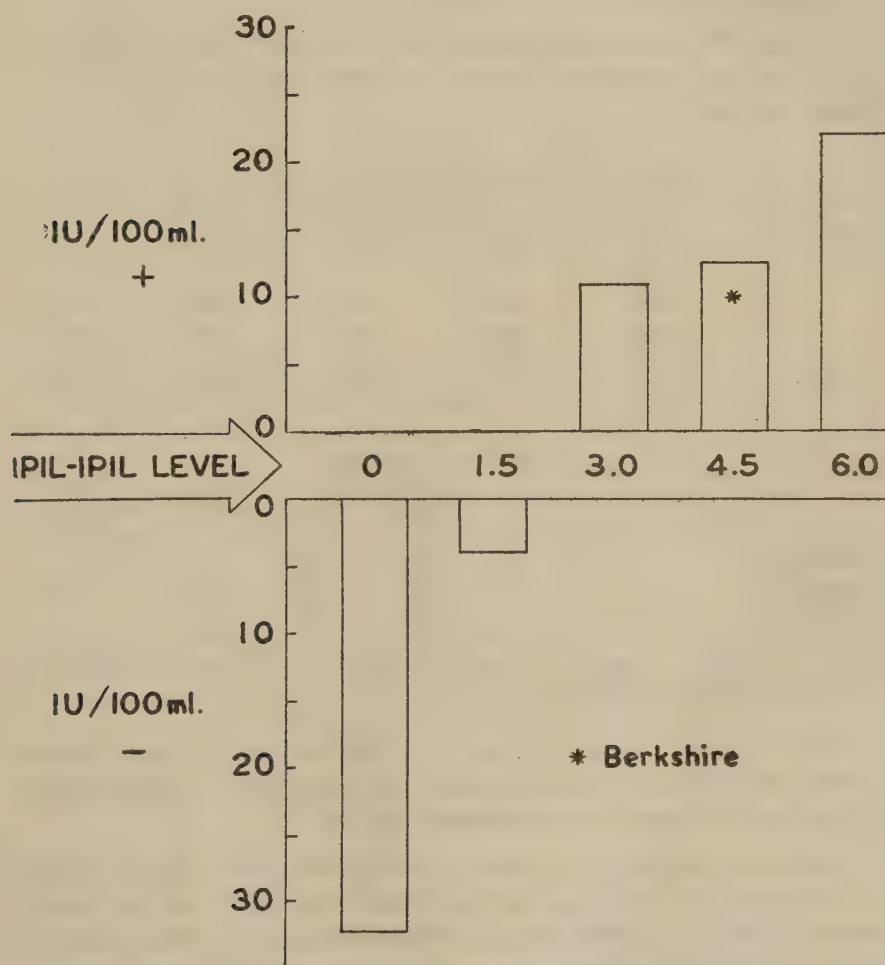


Fig. 1.—Differences of vitamin A (IU/100 ml.) in blood plasma of sows.

Of the sows fed the basal ration (white corn), one gave birth to A from their initial determination. Differences in the plasma vitamin A were statistically significant ($P < .05$).

Weight gain of baby pigs. The higher gains occurred from 5,187 to 15,548 I.U. of vitamin A per kilogram of feed. The highest and lowest levels of vitamin A-fed lots had a comparable depression in gain. The maximum gain in weight of baby pigs was observed in lot IV receiving 15,548 I.U. of vitamin in sow ration (fig. 2).

There were no feed consumption data because the baby pigs were all naturally nursed by their dams.

The growth rate was significant ($P < .05$) in the different dietary vitamin A levels compared, except the basal and the 20,729 I.U. of vitamin A (table 3).

TABLE 3.—Average daily gain of baby pigs ^a

REPLICATES	DIETARY VITAMIN A LEVEL (I.U./KG.)				
	6.16	5,187	10,367	15,548	20,729
I	.075	.046	.172	.202	.039
II	.00	.088	.105	.203	.037
Mean	.037	.067	.138	.202	.038

Analysis of variance

SOURCE OF VARIATION	D.F.	SUMS OF SQUARES	M.S.	COMPUTED F-VALUE	PROB.	H.S.D.
Replication	1	0.093	.093			
Treatment	4	4.111	1.028	8.22	.05	1.51
Replication $\times$ Treatment	4	0.500	.125			
Total	9	4.704				

^a Average daily gain multiplied by 100.

Dietary effect in liver vitamin A. The different dietary vitamin A levels in the ration fed to the sows during gestation were reflected in the liver storage of newborn pigs (fig. 3).

Of these 10 sows, 4 decreased and 6 increased in plasma vitamin five litters which were all dead and blind (fig. 3a). An analysis of vitamin A stored in liver samples obtained from this litter showed a difference of one-half compared to that of the other litters of pigs receiving the same treatment. Frape *et al.* (1959) found a level of 15

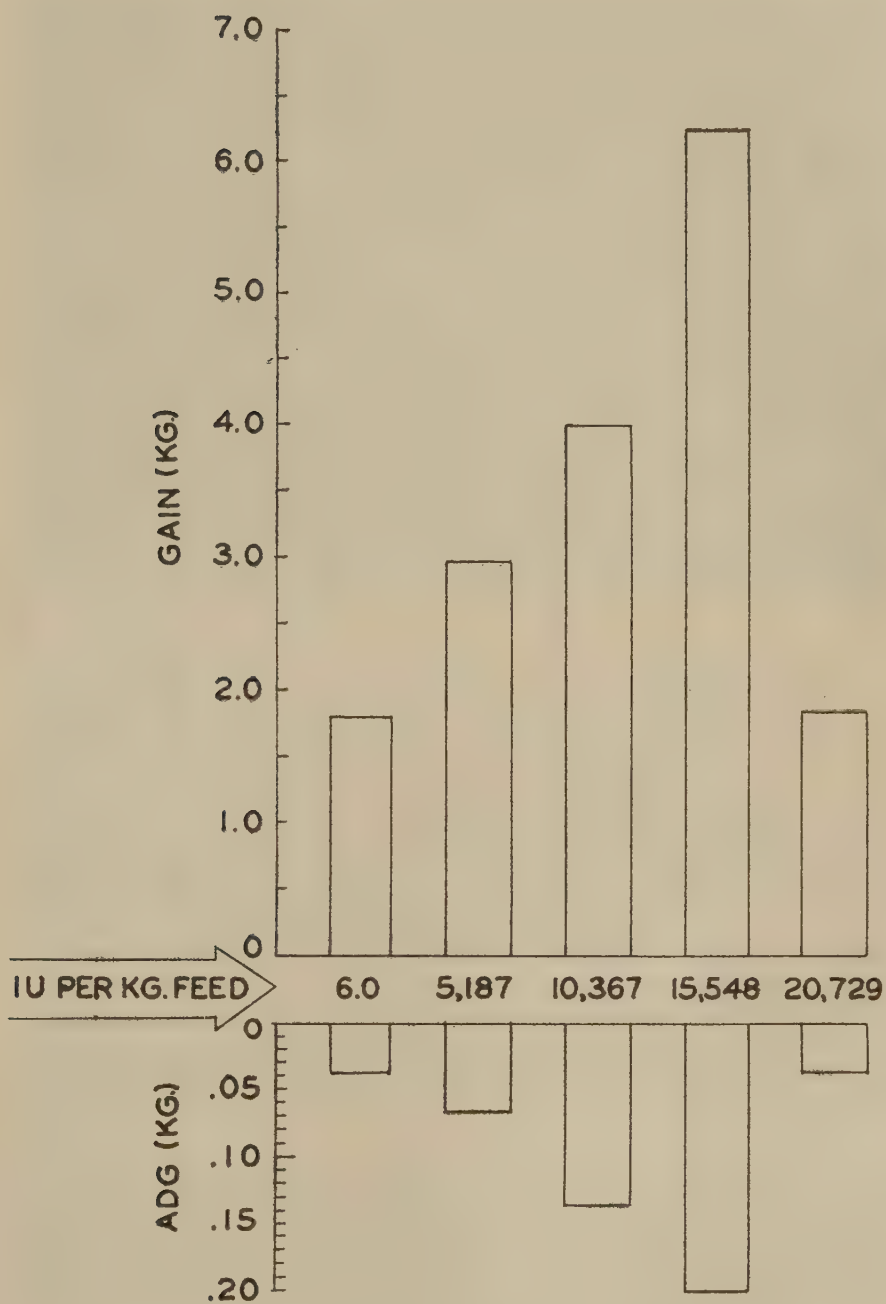
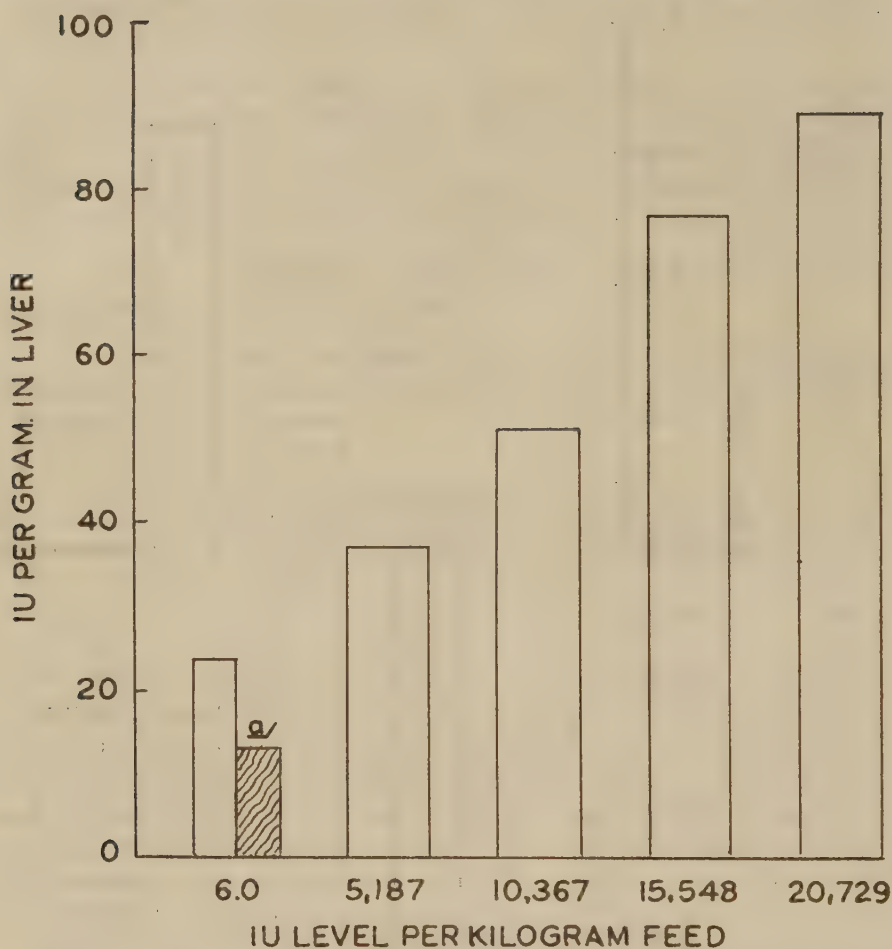


Fig. 2.—Gain in weight of baby pigs.



a/ Born dead and blind

Fig. 3.—Effect of dietary vitamin A in liver vitamin A of pigs.

ug. of vitamin A (approximately 60 I.U.) in the liver of a day-old baby pig. Assuming this value as the minimum level in a normal day-old pig, the dietary vitamin requirement of pregnant sows in this experiment ranged from 10,367 with a liver vitamin A content of 50.94, to 15,548 I.U. with 76.45 I.U. per gram. A more absolute value of the requirement will be defined later.



Fig. 3a.—White corn-fed Duroc sow farrowed to dead and blind litters.

Vitamin A in chick assay. The vitamin A-deficient birds showed paralysis of the legs, sensitivity to light and ruffling of the feathers all over the body. The negative reference group showing some vitamin A storage in the liver probably obtained it from the diet fed to them or the liver vitamin storage in the chick were not fully depleted in the 30-day period. On the other hand, the positive reference group, after the same period of depletion, produced a marked improvement in physical appearance when cod-liver oil (850 U.S.P.) was added in the chick deficient diet. Similarly, dried liver sample from lot II (5,187 I.U. of vitamin A level-fed group) gave a slightly better appearance to the depleted chicks than that from the basal (fig. 4). Further study of the chick assay of the three other levels (10,367, 15,548 and 20,729 I.U.) was prevented by the lack of laboratory materials.

Feed consumption. The sows in all the lots received equal amounts of feeds during the gestation period and were given restricted feeding 10 weeks after breeding and regular feeding 6 weeks before farrowing. Feeding was controlled to prevent the sow from becoming too fat as to cause difficulties at farrowing time. However,

the feed efficiency in all lots had no significant difference. No deficiency symptoms of vitamin A were observed.

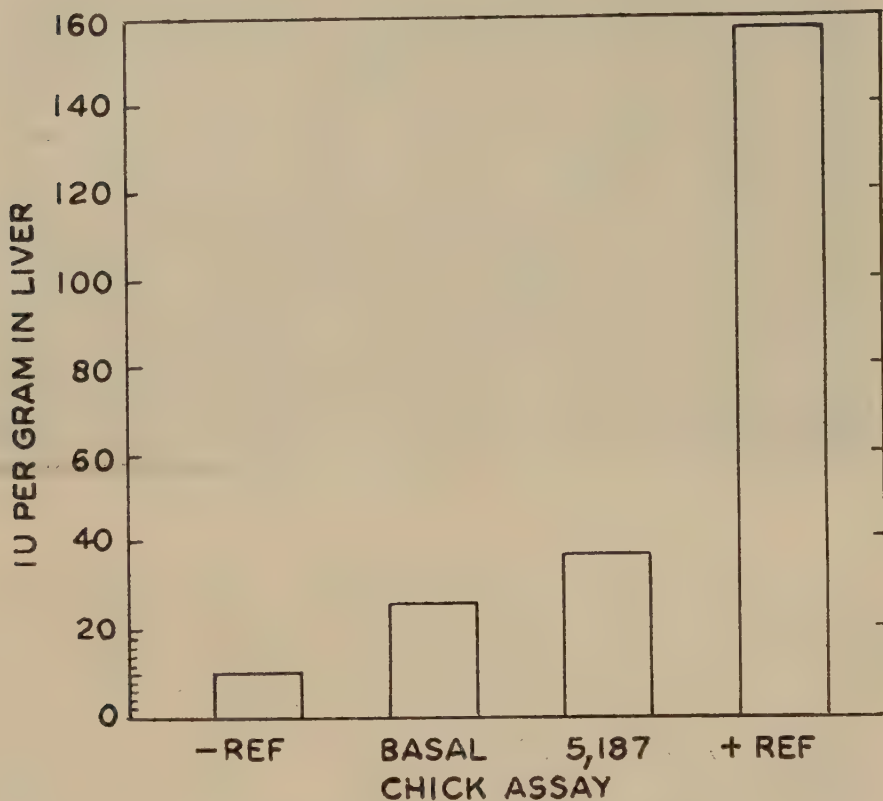


Fig. 5.—Vitamin A recovery from chick assay.

DISCUSSION

The plasma vitamin A in gestating sows was a better criterion than weight gain or loss. Sensitivity in the vitamin A content in the blood was influenced by the dietary level of vitamin A. Although the sows fed the basal ration appeared physically normal, the vitamin A content had an average decrease of 33.18 I.U. per 100 ml. of the blood.

Judging from the differential plasma vitamin A recovery from the different lots, the dietary level from 10,367 to 15,548 I.U. seemed to be adequate for pregnant sows as shown by a slight difference of plasma vitamin A in lots III and IV.

After the second week of age, the pigs in the remaining lot I maintained a fairly rapid rate of gain on the first 2 weeks, which decreased after the second week until weaning. A noticeable lameness of the hindquarters in two of the pigs in this lot was observed. Similarly, the growth of pigs in lot V was depressed on the third week. In one of the litters in lot V, the pigs developed diarrhea and shaggy haircoat which however, should not be mistaken as the effect of the high vitamin A level in the ration received by the nursing sow. It could be the effect of the mimosine content in ipil-ipil leaf meal as reported by Carangal and Catindig (1955).

The use of ipil-ipil leaves as feed for monogastric animals has been limited by the presence of mimosine because ingestion of a large amount of mimosine causes growth reduction, alopecia, and general ill-health. In this case, the mimosine ingested by the mother probably had a carry-over effect to her milk which was sucked by the baby pigs.

In meat production studies, weight gain is the most valid criterion of adequacy if the level of vitamin A leading to maximum gain would result in highest gains under normal conditions that the pig is to encounter in practice. However, maximum gain is not always accompanied by normality in other bodily functions. In this regard, the relationship between the liver vitamin A and dietary levels was put into effect in a regression line, thus establishing a prediction equation.

Assuming that the normal vitamin A content in liver of a day-old pig was 15 ug. per gram as reported by Frape *et al.* (1959), the estimated dietary level needed by the gestating sow would be approximately 12,180 I.U. of vitamin A per kilogram feed (fig. 5), about the level at which other criteria investigated attained normality. When a sufficient amount of vitamin A is provided in the diet of growing pigs to supply adequately all functions in the body, any surplus is stored in the liver. Since all of these gilts, before being used in this experiments, were fed with a developer ration containing 7,076 I.U. of vitamin A during their growing stage, liver vitamin A reserve was at least on the minimum of adequacy.

This point is made clearer in the prediction equation where there is a minimal detectable liver storage at zero dietary level because the fetal nutrients are derived from the maternal reserve in the liver. Experiments in which pregnant females were fed severely deficient

diets showed that although the mother lost weight, the young increased in weight (Nalbandov, 1958).

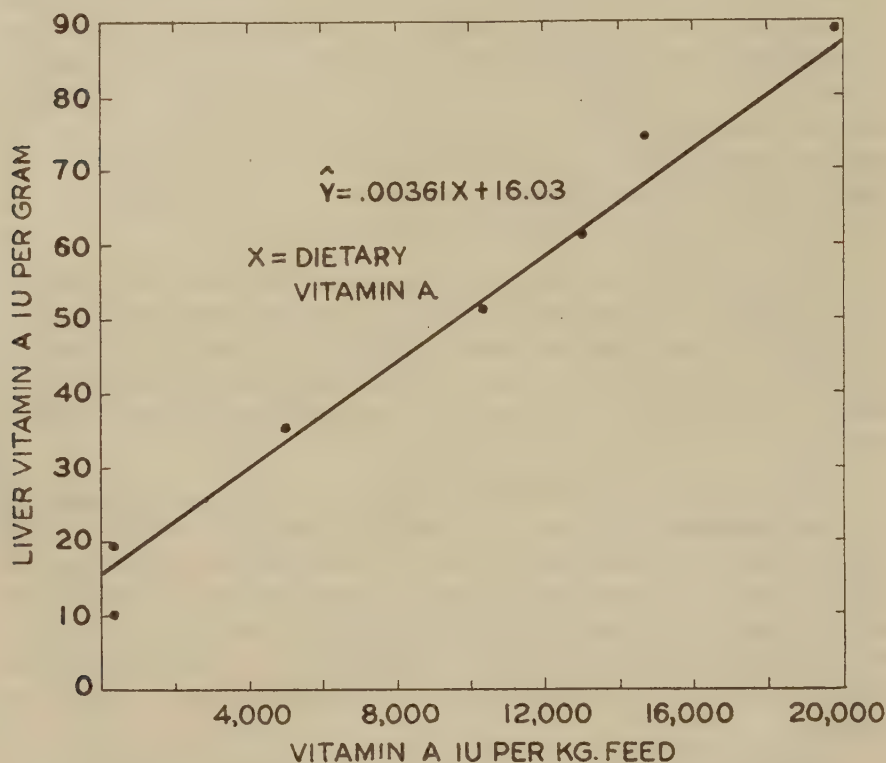
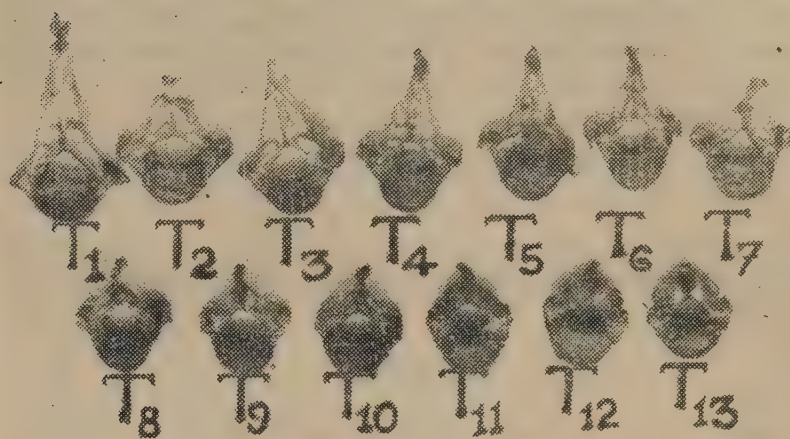


Fig. 5.—Relationship between liver storage vitamin A and dietary level.

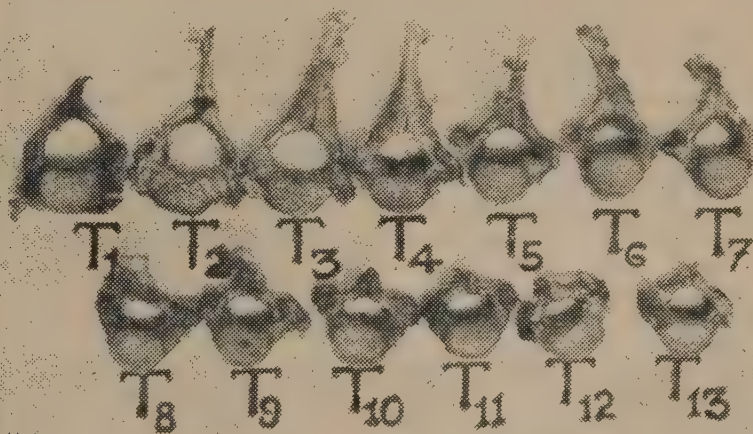
Abnormal and physiological cause. One of the litters on the basal fed ration was born blind and dead. A comparison of the thoracic vertebrae of this litter and a newly born pig from lot II (fig. 6) showed a significant mean difference at 5 per cent level (table 4) in

TABLE 4.—Difference in height and width measurement of thoracic vertebrae in normal and abnormal pigs

STATISTICS	ANTERIOR		POSTERIOR	
	Width	Height	Width	Height
Computed T-value	10.59	9.25	11.18	7.23
Standard error	± 0.205	± 0.187	± 0.229	± 0.292
Mean (mm.)	2.18	1.73	2.56	2.11
Probability	< .01	< .01	< .01	< .01



Thoracic vertebrae of litter from vitamin A deficient diet (approximately 6.0 I.U. per kilogram).



Thoracic vertebrae of litter from let II (which received approximately 5,180 I.U. per kilogram).

Fig. 6.—Diameter difference of the foramen of the thoracic vertebrae from normal and abnormal litters.

the height and width of the foramen, revealing a direct relationship in the over-all size of the diameter of the spinal canal and the induction of the hydrostatic pressure upon the cerebrospinal fluid causing pressure necrosis in the optic nerve. Mellanby (1944) found that in a vitamin A deficient animal, the size of the vertebrae was the same as the normal animals but the spinal canal decreased in diameter, thus inducing more pressure on the cerebrospinal fluid.

The gestation period for the dead and blind litter was 128 days as recorded. The average gestation of swine is 114 days.

The difference in the mortality of the baby pigs in the different treatments during the lactation periods was not significant.

LITERATURE CITED

- THE ASSOCIATION OF VITAMIN CHEMISTS. 1951. Method of vitamin assay. 2nd ed. and suppl. New York: Interscience Publisher, Inc., 301 p.
- BRAUDE, R., A. S. FOOT, K. M. HENRY, S. KON, S. Y. THOMPSON, and T. H. MEAD. 1941. Vitamin A studies with rats and pigs. *Biochem. Jour.* **35**: 693-707.
- CARANGAL, A. R. JR. and A. D. CATINDIG. 1955. The mimosine content of locally grown ipil-ipil (*Leucaena glauca*). *Philippine Agriculturist*. **39**: 249-254.
- FRAPE, D. L. 1955. Review of recent research on fat soluble vitamins. Term Paper on AH 505. Iowa State University.
- FRAPE, D. L., V. C. SPEER, V. W. HAYS, and D. V. CATRON. The vitamin A requirement of young pigs. *Jour. Nutr.* **68**: 173-187.
- HALE, F. 1933. Pigs born without eyeballs. *Jour. Hered.* **24**: 105.
- HENTEGES, J. R. JR., R. H. GRUMMER, P. H. PHILLIPS, and G. BOHSTEDT. 1952. The minimum requirement of young pigs for a purified source of carotene. *Jour. Animal Sci.* **11**: 266-272.
- KIMBLE, M. S. 1939. Photoelectric determination of vitamin A and carotene in human blood plasma. *Jour. Lab. Clin. Med.* **24**: 1055-1065.
- MELLANBY, E. 1944. Nutrition in relation to bone growth and nervous system. *Proc. Roy. Soc., London, Series B.* **132**: 1-28.
- NALEANDOV, A. V. 1958. *Reproductive Physiology*. San Francisco: W. H. Freeman and Co., 271 p.
- NATIONAL RESEARCH COUNCIL. 1959. Nutritional requirement of swine. Publication 648.
- PADGET, C. A. and W. D. IVEY. 1959. Coturnix quail as a laboratory animal. *Science* **129**: 3344, 267-268.

THE FEEDING VALUE OF CORN GLUTEN FEED IN RATIONS FOR LACTATING DAIRY COWS AND GROWING DAIRY HEIFERS ¹

L. L. CLAMOHoy, L. E. NAZARENO, J. S. BONTUYAN,
and P. L. ORDINARIO

WITH ONE TEXT FIGURE

The results of this study show that corn gluten feed can be satisfactorily used as a substitute for copra meal in the rations for lactating dairy cows and growing dairy heifers. Because of its high protein content, high digestibility, bulk and general availability at relatively low cost, corn gluten feed can be used to advantage where it can be bought at prices not exceeding that of copra meal.

Corn gluten feed is a medium-high protein concentrate and is a by-product in the manufacture of corn starch. It has not found a ready market among livestock producers in the Philippines, although in the United States it is a widely used feed especially for dairy cattle.

A study made by Castillo *et al.* (1954)² showed that the chemical analysis and digestibility of corn gluten feed are similar to that reported by Morrison (1951)³. They noted that lactating cows fed a concentrate mixture containing corn gluten feed in place of corn and fish meal gave more milk than those which did not receive corn gluten feed. Turk⁴ reported that in a series of investigations at Cornell University Agricultural Experiment Station, good results were obtained when corn gluten feed was used as one of the protein supplements in the ration.

Because of the availability of corn gluten feed as a medium-high protein concentrate for livestock, it seemed desirable to obtain more information on its feeding value under Philippine conditions. There

¹ Central Experiment Station Contribution No. 2070.

² L. S. Castillo, L. E. Nazareno, and J. K. Loosli, *Philippine Agriculturist* 33, 554 (1954).

³ F. B. Morrison, "Feeds and Feeding," 21st ed., Morrison Publishing Co., Ithaca, N.Y., 1951, 1118 pp.

⁴ K. L. Turk, "Corn Gluten Feed: Its Use and Value in Livestock Rations," A. E. Staley Manufacturing Co., Decatur, Illinois, 1951, 6 pp.

will be a more efficient feeding of livestock if more information on the nutritive value of all available feeds is obtained.

This series of studies was conducted from January, 1955 to January, 1957.

I. CORN GLUTEN FEED VS. COPRA MEAL FOR LACTATING DAIRY COWS

Four Holstein-Friesian, four Holstein-Red Sindhi crossbred, and two Brown Swiss cows were used. The animals were divided into two groups, each composed of lactating cows of different breeds and blood composition but with similar ages and stages of lactation.

The two groups were subjected to a preliminary standardization period of three weeks, followed by three experimental periods of four weeks each in a reversal type of experiment. To remove any possibility of carry-over effects, the data obtained during the first week of each experimental period were not included in the statistical analysis. The animals were placed in the stanchions where they were milked and fed concentrate mixtures.

The amount of concentrate mixture fed to the animals was based on their milk production. For every two and a half kilograms of milk produced, one kilogram of concentrate mixture was given. The animals were fed individually two times a day, between 4 and 5 a.m. and between 2 and 3 p.m.

The ration contained the following ingredients and percentages.

INGREDIENTS	MIXTURE 1	MIXTURE 2
	<i>per cent</i>	<i>per cent</i>
Ground yellow corn	31	31
Fine rice bran	31	31
Corn gluten feed	31	31
Copra meal	—	31
Fish meal	5	5
Ground oyster shells	1	1
Salt	1	1
Total	100	100

In addition, the animals were fed once daily with corn silage just after milking, and allowed to graze on the same pasture.

Records of daily milk production and grain and silage consumption were taken. The Babcock test was performed once a week to deter-

mine the fat content of the milk. Samples of the two mixtures from each of the three periods were taken for chemical analyses.

The animals were weighed for three successive days at the beginning and at the end of each experimental period, and their weights were recorded.

RESULTS AND DISCUSSION

The average chemical composition of the two experimental concentrate mixtures is shown in table 1. As the table shows, the corn gluten feed mixture was slightly higher in protein and nitrogen-free extract but was lower in ether extract and crude fiber than the copra meal mixture.

TABLE 1.—*Chemical composition of the concentrate mixtures*^a

NUTRIENT	MIXTURE 1 ^b	MIXTURE 2 ^c
	<i>per cent</i>	<i>per cent</i>
Moisture	8.89	9.49
Crude protein	15.44	13.57
Ether extract	3.35	4.63
N. F. E.	57.20	52.68
Crude fiber	7.30	9.71
Ash	7.82	9.92

^a Average chemical composition of feeds for the three periods.

^b With corn gluten feed.

^c With copra meal.

A summary of the effects of feeding copra meal and corn gluten feed as part of the concentrate mixture to lactating cows is presented in table 2.

Milk production. In addition to the data in table 2, the average daily milk production per cow (4% F. C. M.) in the two groups is shown graphically in figure 1.

There was a downward trend in milk production due to the advance in stage of lactation. The cows produced slightly more milk per day on the corn gluten feed ration; however, statistical analyses indicated that these differences were not significant in milk production, fat percentages, and 4 per cent fat-corrected milk on the two concentrate mixtures containing copra meal and corn gluten feed.

TABLE 2.—*Summary of the effects of feeding either copra meal or corn gluten feed as 31 per cent of the concentrate mixture to dairy cows*

MEASUREMENT (KG./COW/DAY)	AVERAGE VALUES FOR 3 WEEK-PERIODS IN CHANGE-OVER DESIGN WHEN FED:	
	Corn gluten feed	Copra meal
Milk production	5.54	5.06
Fat production	0.19	0.21
4 per cent fat-corrected milk	5.04	5.08
Weight gain or loss	+0.05	-0.13
Grain consumption	2.31	2.43
Silage consumption	6.07	6.21

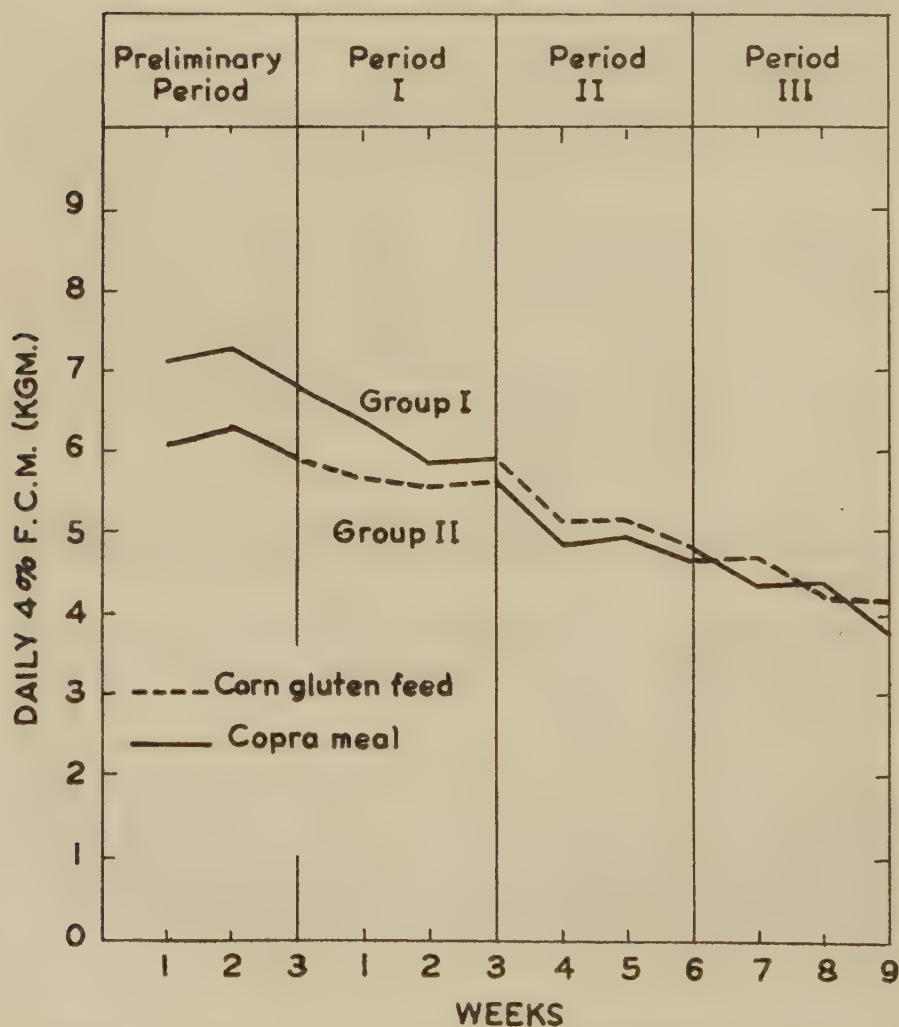


Fig. 1.—Average daily (4% F. C. M.) milk production given at weekly intervals.

These results compare favorably with those of the experiments reported from the United States showing that linseed meal, peanut meal, soybean oil meal, and corn gluten feed are about equal as protein supplements in rations fed to dairy cows.

Weight changes. Weight changes of the animals are summarized in table 2. While there were individual changes in weights of the cows during the course of the experiment, statistical analyses did not show any significant differences due to the feeds being tested.

Feed consumption. Any differences obtained in feed consumption of the cows on the two rations were insignificant. These data and observations indicate that the mixture containing corn gluten feed was just as palatable as that containing copra meal.

SUMMARY

The information from this experiment supplements that obtained earlier by Castillo *et al.* (1954)⁵ in showing that corn gluten feed is a satisfactory ingredient in concentrate mixtures for lactating cows and can be used as efficiently as copra meal.

II. CORN GLUTEN FEED VS. COPRA MEAL FOR GROWING DAIRY ANIMALS

Ten growing dairy heifers—eight Holstein-Red Sindhi crossbred and two purebred Red Sindhi—were used in a feeding trial for 12 weeks. The heifers, paired according to breed or blood composition, size, and weight, were assigned at random into two groups of five animals each. One group served as the control (Lot I, with copra meal) and the other as the experimental group (Lot 2, with corn gluten feed). Each group was confined in a 10-square meter lot during the whole feeding period.

The concentrate mixtures fed to the animals were similar in composition to those given during the first experiment on lactating cows.

The animals were group-fed with the concentrate mixture once daily at the rate of 2 kilograms per head. At the start of the experiment, corn silage was given once a day at about 4 p.m. at 4 kilograms per head. The daily allowance was gradually increased as the animals became older and gained in weight. From the sixth to the tenth week, the amount fed was limited to 7 kilograms per

⁵ Castillo, *et al.*, *op. cit.*

head daily because of the limited supply of the silage. During the last two weeks, it was necessary to use sugar cane silage because the supply of corn silage had been exhausted. Silage weighbacks were taken of the silage not consumed during the previous feeding. Usually, however, no weighbacks were obtained.

Fresh water and granulated salt were made available to the animals at all times.

Samples of the feeds were taken during the trial and were analyzed at the Central Experiment Station analytical laboratory.

The weights of the animals and the measurements of the height at withers, heart girth, and barrel were taken for three consecutive days at the start and at the end of the experiment and for three successive days every 28 days. The average of three successive weighings and measurements represented the data for each 28 days. All weights and measurements were taken early in the morning before the animals were fed.

RESULTS AND DISCUSSION

Table 3 shows the chemical composition of the experimental feeds used in this study. There are only slight differences from the composition of the mixtures used in the previous experiment.

TABLE 3.—*Chemical composition of copra meal and corn gluten feed and of the concentrate mixtures used in experiment with growing dairy animals (per cent)*

FEED	MOISTURE	CRUDE PROTEIN	ETHER EXTRACT	CRUDE FIBER	N.F.E.	ASH
Copra meal	8.08	21.75	8.32	7.70	47.75	6.40
Corn gluten feed	9.00	24.66	2.17	5.06	57.31	1.80
Lot 1 Mixture						
(With copra meal)	9.30	14.36	5.30	9.30	52.25	9.49
Lot 2 Mixture						
(With corn gluten feed)	9.31	15.94	4.53	9.09	53.86	7.27

A comparison of the animals in both groups during the entire period showed the same daily gain in weight of 0.53 kilogram (table 4). Obviously, this indicates that corn gluten feed and copra meal were equal in feeding value when evaluated by weight changes.

TABLE 4.—*Comparison of corn gluten feed with copra meal for growing dairy heifers (12 weeks)*

ITEM	LOT 1 (WITH COPRA MEAL)	LOT 2 (WITH CORN GLUTEN FEED)
Number of animals	5	5
Average weight of animals		
Initial, kgm.	143.80	144.67
Final, kgm.	188.00	189.06
Total gain, kgm.	44.20	44.39
Daily gain, kgm.	0.53	0.53
Average height at withers		
Initial, cm.	101.10	99.95
Final, cm.	105.47	106.37
Total increase, cm.	4.37	6.42
Average heart girth		
Initial, cm.	116.32	117.60
Final, cm.	126.44	128.98
Total increase, cm.	10.12	11.38
Average circumference of barrel		
Initial, cm.	138.62	135.86
Final, cm.	156.83	155.08
Total increase, cm.	18.21	19.22
Average daily feed consumption		
Corn silage, kgm.	6.30	6.31
Ground corn, kgm.	0.62	0.62
Copra meal, kgm.	0.62	—
Corn gluten feed, kgm.	—	0.62
Rice bran (fine), kgm.	0.62	0.62
Fish meal, kgm.	0.10	0.10
Total digestible nutrients, kgm. ^a	5.84	5.85
Feed required per 100 kgm. gain ^b		
Corn silage, kgm.	1,197.19	1,193.29
Ground corn, kgm.	117.83	117.32
Copra meal, kgm.	117.83	—
Corn gluten feed, kgm.	—	117.32
Rice bran (fine), kgm.	117.83	117.32
Fish meal, kgm.	19.00	18.92
Total digestible nutrients, kgm. ^a	1,007.60	1,005.21

^a Calculated from the chemical composition and average digestion coefficients (average digestion coefficients from F. B. Morrison's Feeds and Feeding, Appendix table 1, 1951).

^b Calculated from the total gain in weight and total feed consumed per animal.

There were small differences in the average height, heart girth, and circumference of the barrel favoring the animals on the corn gluten feed ration, but they were not significant (table 4).

The average daily concentrate and roughage consumption of the animals in both lots are shown in table 4. Each animal in Lot I consumed an average of 6.30 kilograms of corn silage daily; each in Lot 2, 6.31 kilograms. The daily average concentrate intake was constant at 2 kilograms for each animal. Although limited feeding of silage was followed, the additional nutrients the heifers required as they grew in size were provided for by increasing the amount of roughage fed daily.

The total digestible nutrients of the feeds in both groups were calculated from the chemical composition and the average digestion coefficients for the feeds consumed daily by the heifers in both groups. The heifers fed with the grain mixture containing copra meal consumed an average of 5.84 kilograms of total digestible nutrients daily; those on the ration with copra gluten feed, 5.85 kilograms.

The total amount of each ingredient consumed multiplied by the proportion of the same ingredient per 100 kilograms of feed and the product divided by the total gain in weight per animal represented the feed per 100 kilograms. The total digestible nutrients required per 100-kilogram gain for Lot I was 1007.60 kilograms and for Lot 2, 1005.21 kilograms. Apparently, the total digestible nutrients required for a 100-kilogram gain were identical for both lots, indicating that corn gluten feed and copra meal were equal in feeding value.

THE EFFECT OF BONE MEAL IN RATION FOR GROWING DAIRY CATTLE AND MURRAH CARABAOS¹

TEOFILO A. DULAY, CLEDUALDO B. PEREZ, JR., BIENVENIDO B. RAMIN,
and LOURDIO L. CLAMOHAY

For growing dairy cattle and Murrah carabaos, no significant advantage was gained by supplementing a basal ration already adequate in calcium and phosphorus with one per cent steamed bone meal. The experimental animals made a slightly higher gain in liveweight and body measurements and required less amount of concentrate feeds to produce a kilogram gain in weight than the control animals. There was no significant difference in the blood calcium and phosphorus levels of the control and experimental animals.

Growing dairy cattle are fed primarily to enable them to have the best growth and development possible in preparation for their future long-time performance in milk production.

Growing dairy cattle raised either on excellent pasture with plenty of good quality legumes or in the barn supplied with good quality legume roughages usually suffer only from slight phosphorus deficiency. When fed concentrates, mostly cereal grains and their by-products, there seems to be an adequate amount of phosphorus in their ration. However, since the phosphorus in cereals is mostly in the form of phytin which may not be well-utilized by young cattle, the addition of inorganic phosphorus supplement in the ration may be advantageous. Bone meal is one of the most common inorganic phosphorus supplements being used for livestock feeding. It supplies not only phosphorus but twice as much of calcium and appreciable amounts of protein and fat.

Conflicting results have been reported regarding the beneficial effect of the addition of bone meal in a ration which otherwise is already adequate in calcium and phosphorus. Salmon and Eaton (1925) reported that there was only a slight difference in the rate of growth of growing dairy heifers fed ration with and without bone meal. However, a report of the Michigan Agricultural Experiment Station (1929-1930) stated that a group of dairy heifers fed with a basal ration containing .41 per cent phosphorus and .20 per

¹ Central Experiment Station Contribution No. 2071.

cent calcium on a dry matter basis without bone meal did not make as good a growth as a similar group fed with the same ration supplemented with bone meal. Since these results are contradicting, further studies are necessary to find out if under Philippine conditions, either of the two reports apply.

This study was conducted from August, 1958, to September, 1959, to determine the effect of a supplement of bone meal on growing dairy cattle and Murrah buffaloes.

MATERIALS AND METHODS

This study was carried out in two experiments. Experiment II, which was a continuation of experiment I, was conducted in a shorter period and the blood analysis for calcium and inorganic phosphorus was considered. Both experiments have a common objective.

Eight grade dairy heifers and four female Murrah buffaloes ranging from six to seven months in age were used in experiment I. They were selected on the basis of age, liveweight, blood composition, and health. In assigning the animals to lots, pairing was done first, after which the members of each pair were randomly assigned to the two different lots. Lot I (control) and Lot II (experimental) had four cattle and two Murrahs, respectively.

The concentrate mixtures used consist of the following ingredients, all parts by weight.

INGREDIENTS	RATION A	RATION B
	(Control)	(Experimental)
Yellow corn, ground	25	25
Rice bran, fine	30	30
Copra meal	20	20
Corn gluten feed	10	10
Molasses, cane	10	10
Soybean oil meal	5	5
Salt (NaCl)	1	1
Bone meal, steamed	—	1
Total	101	102
Digestible protein (DP), per cent	12.28	12.42
Total digestible nutrients (TDN), per cent	73.21	73.48
Crude fiber, per cent	8.22	8.23
Calcium, per cent	0.19	0.49
Phosphorus, per cent	0.73	0.88
Calcium: Phosphorus ratio	1:3.8	1:1.7

The two lots were provided with four improved pastures (mostly para grass herbage) which were used in rotation during the period. Eight 3' $\times$ 5' pens were constructed in each pasture to confine the animals individually during concentrate feeding time.

Each animal in both lots was fed concentrates daily at the rate of 0.5 per cent of the liveweight. The latest recorded liveweight of an animal was used as the basis for estimating the daily concentrate allowance. Feeding of concentrates was done twice a day, at 5 to 8 a.m. and 4 to 6 p.m. After the feeding time, the animals of both lots were allowed to graze in the same pasture. Salt and water were made available at all times in the pasture.

The average of three consecutive weighings and body measurements (height, body length, and heart girth) of each animal at the start and end of the experiment were considered as the initial and final liveweight and body measurements of the animal, respectively. During the experiment, the animals were weighed every two weeks and body measurements were taken every month.

Soil samples were taken from the different pasture lots for chemical analyses of the exchangeable calcium and phosphorus levels at the start of the experiment.

In experiment II, six grade heifers, four bull calves, and four Murrah heifers ranging from five and one-half to six months of age were used. Methods and procedures identical to those used in experiment I were followed. In addition to the liveweight and body measurement data, blood samples (20-30 milliliters per animal) were taken from the animals of both lots at the start of the experiment and every month thereafter for chemical analyses of calcium and inorganic phosphorus. Before the day of sampling, the animals were kept in the barn at night and bled in the morning about three hours after the feeding of concentrates. This procedure was followed to reduce to a minimum the effect of exercise.

RESULTS AND DISCUSSION

Rate of growth. Table 1 shows the average liveweight and body measurement data for both experiments. In experiment I, the heifers in Lot II (experimental) made an average daily gain in weight of 0.49 kilogram as compared to 0.43 kilogram for those in Lot I (control). The Murrah heifers made an average daily gain of 0.49 and 0.38 kilograms for Lot II and Lot I, respectively. In

TABLE 1.—Effect of bone meal on growth and feed consumption of growing dairy cattle and Murrah buffaloes

ITEMS	EXPERIMENT I				EXPERIMENT II							
	Heifers		Murrah Heifers		Heifers		Bull Calves		Murrah Heifers		Lot I Control	Lot II Expt'l
	Lot I Control	Lot II Expt'l	Lot I Control	Lot II Expt'l	Lot I Control	Lot II Expt'l	Lot I Control	Lot II Expt'l	Lot I Control	Lot II Expt'l		
Number of animals	4	4	2	2	3	3	2	2	2	2	2	2
Number of days on trial	213	213	213	213	92	92	92	92	92	92	92	92
Average weight of animals (kg.):												
Initial	150.00	147.50	112.75	113.50	124.16	125.66	108.50	112.50	139.50	143.50		
Final	242.12	253.00	195.55	219.75	158.66	163.00	139.00	156.50	177.50	179.50		
Total gain	92.12	105.50	82.80	106.25	34.50	37.34	30.50	44.00	38.00	36.00		
Daily gain	.43	.49	.38	.49	.37	.40	.33	.43	.40	.39		
Average height (cm.):												
Initial	102.25	98.75	91.65	92.75	94.66	93.50	91.00	91.25	101.00	101.75		
Final	115.57	113.70	106.90	109.55	102.50	101.66	101.75	104.75	112.25	111.00		
Total increase	13.32	14.95	15.25	16.80	7.84	8.16	10.75	13.50	11.25	9.25		
Daily increase	.06	.07	.07	.08	.08	.09	.11	.13	.12	.10		
Average length (cm.):												
Initial	104.05	104.70	86.90	86.25	99.33	98.66	93.75	93.00	95.50	96.50		
Final	119.10	122.90	104.75	107.75	107.33	110.00	104.50	106.25	103.50	104.50		
Total increase	15.05	18.20	17.85	21.50	8.00	11.34	10.75	13.25	8.50	8.09		
Daily increase	.08	.07	.08	.10	.08	.12	.11	.14	.09	.08		

TABLE 1 (continued)

ITEMS	EXPERIMENT I				EXPERIMENT II							
	Heifers		Murrah Heifers		Heifers		Bull Calves		Murrah Heifers			
	Lot I Control	Lot II Expt'l	Lot I Control	Lot II Expt'l	Lot I Control	Lot II Expt'l	Lot I Control	Lot II Expt'l	Lot I Control	Lot II Expt'l	Lot I Control	Lot II Expt'l
Average heart girth (cm.):												
Initial	123.82	120.05	118.50	119.75	122.56	120.33	110.50	117.50	132.00	132.50		
Final	138.00	136.77	144.55	148.00	129.83	129.83	117.00	127.50	147.25	134.50		
Total increase	15.18	16.72	26.05	28.25	7.27	9.50	6.50	10.00	15.25	12.00		
Daily increase	.07	.08	.12	.13	.07	.10	.07	.10	.16	.13		
Concentrate feed consumption:												
Ave. total concentrate feed consumption/animal (kg.)	206.61	208.73	157.62	181.05	64.38	65.32	52.44	58.88	69.00	61.64		
Ave. daily concentrate feed consumption/animal (kg.)	.97	.98	.74	.85	.69	.71	.57	.64	.75	.67		
Ave. amount of concentrate per kg. gain in weight (pesos) ^a	2.24	1.97	1.90	1.62	1.86	1.74	1.71	1.33	1.86	1.71		
Cost of concentrate feed per kg. gain in weight (pesos) ^a	0.34	0.31	0.29	0.26	0.28	0.27	0.26	0.21	0.28	0.27		
Total concentrate feed cost (pesos)	126.44	130.24	48.22	56.48	29.55	30.57	16.04	18.36	21.10	19.22		

^a Cost of concentrate feed, per kg., Lot I, ₱0.153; Lot II, ₱0.156.

the case of the latter group, the slightly bigger difference in daily gains may be attributed to the higher concentrate feed consumption of the Murrah heifers in Lot II. In both cases, however, the differences in gain in weight and feed consumption were statistically insignificant.

Likewise, the differences in body measurements of height, length and heart girth between the two lots were found to be statistically insignificant.

The results in experiment II followed a trend similar to those in experiment I. The Lot II (experimental) animals had a slightly higher average daily gain in liveweight and body measurements. In the case of the Murrah heifers, the Lot I (control) animals had a slightly higher average gain. This is due to their relatively higher concentrate feed consumption.

The differences in gain in liveweight and body measurements between lots were statistically insignificant.

Calcium and phosphorus intake. The pastures used in both experiments were found to be adequate in exchangeable calcium and phosphorus (table 2).

TABLE 2.—*Levels of exchangeable calcium and phosphorus in the soil, p.p.m.*

PASTURE LOT NO.	CALCIUM	PHOSPHORUS
1	3720	12
2	2879	12
3	3112	17
4	3095	13

Table 3a shows the comparative average daily intake of calcium and phosphorus from the concentrate mixture of the animals in both lots in experiment I. Lot I heifers consumed an average of 1.83 grams of calcium and 6.96 grams of phosphorus per head daily. On the other hand, Lot II heifers consumed an average of 4.55 grams of calcium and 8.30 grams of phosphorus. In the case of the Murrah heifers, the average daily intake was 1.39 grams of calcium and 5.29 grams of phosphorus per head for Lot I and 4.00 grams of calcium and 7.19 grams of phosphorus for Lot II. These amounts are lower than the daily allowances of calcium and phosphorus recom-

mended by the U.S. National Research Council. However, since the animals were allowed to graze liberally on good grass pastures, the daily requirements of calcium and phosphorus were sufficiently met by the amount of herbage they normally consumed.

TABLE 3a.—Average daily intake of calcium and phosphorus per head from concentrate mixture, grams

EXPERIMENT I

LOT	HEIFERS					
	Basal Ration		Bone Meal		Total	
	Ca	P	Ca	P	Ca	P
I	1.83	6.96	—	—	1.83	6.96
II	1.84	6.99	2.71	1.30	4.55	8.30

TABLE 3a (continued)

LOT	MURRAH HEIFERS					
	Basal Ration		Bone Meal		Total	
	Ca	P	Ca	P	Ca	P
I	1.39	5.29	—	—	1.39	5.29
II	1.59	6.03	2.40	1.16	4.00	7.19

Table 3b shows the average daily intake of calcium and phosphorus from concentrate mixture by the animals in both lots in experiment II. As in experiment I, the animals in both lots consumed relatively more phosphorus than calcium from the concentrates, and the Ca:P ratio was wider for Lot I.

Calcium and phosphorus levels in blood plasma. According to Maynard and Loosli (1956), the calcium and phosphorus levels in

TABLE 3b.—Average daily intake of calcium and phosphorus per head from concentrate mixture, grams

EXPERIMENT II

LOT	HEIFERS					
	Basal Ration		Bone Meal		Total	
	Ca	P	Ca	P	Ca	P
I	1.33	5.11	—	—	1.33	5.11
II	1.35	5.16	2.16	1.05	3.51	6.21

TABLE 3b (continued)

LOT	BULL CALVES					
	Basal Ration		Bone Meal		Total	
	Ca	P	Ca	P	Ca	P
I	1.10	4.23	—	—	1.10	4.23
II	1.22	4.66	1.90	0.92	3.12	5.58

TABLE 3b (continued)

LOT	MURRAH HEIFERS					
	Basal Ration		Bone Meal		Total	
	Ca	P	Ca	P	Ca	P
I	1.45	5.55	—	—	1.45	5.55
II	1.27	4.86	1.91	0.90	3.24	5.81

the blood are important indicators of the state of mineral nutrition. In most species, the serum in health, contains from 9 to 12 milligrams of calcium per 100 ml. and 4 to 9 milligrams of phosphorus. The phosphorus level is higher at birth than at maturity, the most rapid decline occurring early in life.

The data on average level of calcium and phosphorus in blood plasma of all animals in experiment II are presented in tables 4a and 4b. The same trend can be observed with the levels of both elements in all the animals of both lots. For both elements, the initial levels at the start of the experiment were markedly higher than the levels after one month of experimental feeding. This may be attributed to the fact that the animals, before the start of the experiment, were raised on calf starter high in calcium and phosphorus. Similar observations have been previously reported by Huffman and co-workers (1933). Then the animals were transferred to a feeding system whereby the concentrate mixtures used, though high in calcium and phosphorus, were hand-fed (controlled feeding). Some of the values obtained were higher than the observed normal levels of calcium and phosphorus as reported by Maynard and Loosli (1956). In the case of calcium, some levels were lower than the normal value of 9 milligrams per 100 milliliters of blood plasma. In general, the variation in levels among animals and in the same animal at different times may be due to the effect of several opposing factors like absorption, excretion, deposition, and mobilization as reported by the same authors. Meigs, Blatherwick, and Cary

TABLE 4a.—Average calcium level in blood plasma, mg. per 100 ml.

LOT	HEIFERS				BULL CALVES				MURRAH HEIFERS			
	Experimental Months				Experimental Months				Experimental Months			
	Initial	1st Mo.	2nd Mo.	3rd Mo.	Initial	1st Mo.	2nd Mo.	3rd Mo.	Initial	1st Mo.	2nd Mo.	3rd Mo.
I	14.84	8.88	8.24	7.06	11.54	6.64	7.59	6.96	14.39	6.64	5.62	10.12
II	12.85	7.49	7.90	8.01	16.76	9.41	5.17	7.58	12.02	8.38	5.62	9.49

TABLE 4b.—Average phosphorus level in blood plasma, mg. per 100 ml.

LOT	HEIFERS				BULL CALVES				MURRAH HEIFERS			
	Experimental Months				Experimental Months				Experimental Months			
	Initial	1st Mo.	2nd Mo.	3rd Mo.	Initial	1st Mo.	2nd Mo.	3rd Mo.	Initial	1st Mo.	2nd Mo.	3rd Mo.
I	8.77	5.74	12.55	8.64	9.76	6.39	8.85	10.57	7.84	7.36	10.14	9.12
II	10.40	6.34	10.88	9.19	10.21	7.93	12.22	10.82	9.15	6.67	7.92	9.56

(1919) reported that the inorganic phosphorus levels in the blood were highly variable not only from animal to animal but also in the same animal examined at different times.

As far as the blood plasma levels of the elements are concerned, bone meal was found to have exerted no effect. However, Maynard and Loosli (1956) mentioned that normal levels do not guarantee a normal state of bone nutrition.

Feed consumption and feed efficiency. Table 1 shows that the average daily concentrate feed consumption per animal in experiment I is 0.97 kilogram for Lot I heifers and 0.98 kilogram for Lot II; in the case of the Murrah, 0.74 kilogram for Lot I and 0.85 kilogram for Lot II. The heifers in Lot I required 2.24 kilograms of concentrates to make a kilogram gain in weight while those in Lot II required only 1.97 kilograms; the Murrah heifers in Lot I needed 1.90 kilograms and those in Lot II, 1.62 kilograms.

In experiment II, the average daily concentrate feed consumption per head in Lot I were as follows: 0.69 kilogram for heifers, 0.57 kilogram for bull calves and 0.75 kilogram for Murrahs; in Lot II, 0.71, 0.64, and 0.67 kilogram, respectively. It can be seen that the animals in Lot II have a slightly higher daily concentrate feed consumption. The exception are the Murrah heifers of Lot I which had a higher feed consumption.

As in experiment I, the animals in Lot II (experimental) required a slightly less amount of concentrate to make a kilogram gain in liveweight. Again, these differences were statistically insignificant.

Economy of gain. Based on the price of feeds when the experiment was conducted, ₱0.34 worth of concentrates was needed to produce a kilogram gain in weight of the heifers in Lot I as compared to ₱0.31 in Lot II; the Murrahs in Lot I needed ₱0.29 worth and those in Lot II, ₱0.26. This observation was made in experiment I.

In experiment II, ₱0.28 worth of concentrates was needed to produce a kilogram gain in weight in heifers in Lot I, as compared to ₱0.27 in Lot II; ₱0.26 for bull calves in Lot I and ₱0.21 in Lot II; ₱0.28 for Murrah in Lot I and ₱0.27 in Lot II.

LITERATURE CITED

- HUFFMAN, C. F. and C. S. ROBINSON. 1933. Jour. Dairy Sci. **16**: 203-220.
- MAYNARD, L. A. and J. K. LOOSLI. 1956. Animal nutrition. New York: McGraw-Hill Book Co. pp. 111-129.
- MEIGS, E. B., N. R. BLATHERWICK, and C. A. CARY. 1919. Jour. Biol. Chem. **37**: 1-75.
- MICHIGAN AGRIC. EXPT. STA. BIEN. RPT. 1929-1930. pp. 18-23.
- SALMON, W. D. and W. H. EATON. 1925. Jour. Dairy Sci. **8**: 312.

BIOSYNTHESIS OF C¹⁴-LABELED COCONUT MEAT: I. INCORPORATION OF NaHC¹⁴O₃¹

A. R. CARANGAL, JR. and C. R. BARIL

The preparation of labeled coconut meat by the non-photosynthetic fixation of CO₂ was studied. Tissue slices of coconut endosperm, however, did not fix C-14-labeled bicarbonate.

Copra is one of the most important products from coconut. Copra meal, which results after oil is extracted from copra, is widely used as animal feed. Most investigations on copra meal deal with its feeding value. Probably, this product can be more effectively utilized if more information on its transformation during its digestion by the animal is obtained. This line of work can best be followed with the use of radiotracers.

Because of the morphology of the coconut and the length of time the nut needs to develop, it will be quite difficult to produce C¹⁴-labeled fruit by photosynthesis in the presence of C¹⁴-labeled CO₂. Mazelis and Vennesland² have reported non-photosynthetic CO₂ fixation in higher plants. Herbert,³ in his analysis of the gas present in the young coconut, found traces of CO₂. This present report deals with the possibility of using such fixation mechanism in the formation of labeled meat by incorporation of C¹⁴-labeled NaHCO₃.

MATERIALS AND METHODS

Tissue slices of endosperm from green coconut were cultured in 10 ml. of distilled water containing 10 microlites (ul.) of radioactive NaHC¹⁴O₃. An aliquot of this culture medium was assayed for activity.

The reaction mixture was shaken frequently during the 3-hour period culture, after which the solution was decanted. The endosperm slices were washed repeatedly with 10 ml. of 2 per cent phosphoric acid solution to remove the unreacted NaHC¹⁴O₃. The slices were then extracted with 20 ml. of 80 per cent ethyl alcohol solution. The alcohol extract was assayed for activity. Two trials were made.

¹ Central Experiment Station Contribution No. 2072.

² M. Mazelis and B. Vennesland, *Plant Physiology* **32**, 591 (1957).

³ D. A. Herbert, *Philippine Agriculturist* **11**, 177 (1923).

In another experiment, tissue slices (1.5 gms.) of the endosperm were cultured in 10 ml. of coconut water to simulate actual conditions in the green nut. To this culture medium was added 10 microliters of NaHC¹⁴O₃. Alcoholic extract was prepared after three hours of culture following the procedure discussed above.

The activities in the culture media and alcoholic extracts were assayed with a Geiger-Mueller end-window counter (1.4 mg/cm²) and standard scaling circuit (Nuclear Chicago Rediscaler Model 180). Aliquots of 0.2 ml. were plated on glass planchets.

RESULTS AND DISCUSSION

There was no fixation of C¹⁴-labeled bicarbonate by the coconut endosperm as shown by the negligible activity of the alcoholic extract (table 1). The amount of activity in the alcoholic extract of the cultured tissues is insignificant compared to the initial activity of the added bicarbonate. Similar results were obtained in the water culture and under conditions simulating that of the nut.

TABLE 1.—*Culture of excised endosperm in NaHC¹⁴O₃ solution*

CULTURE EXPERIMENT	NaHC ¹⁴ O ₃ ADDED	TOTAL ACTIVITY	
		Culture medium	Alcoholic extract
	ug.	cpm.	cpm.
I. 1.5 grams tissue plus 10 ml. of H ₂ O	0.28	75,700	0
II. 3 grams tissue plus 10 ml. of H ₂ O	0.57	159,750	345
III. 1.5 grams tissue plus 10 ml. of coconut H ₂ O	0.56	158,970	411

These results suggest that conditions in the nut are not favorable for the fixation of CO₂. Possibly, the CO₂ produced during the respiratory processes in the fruit is not utilized but escapes from the fruit through its germinal pore. Squires, Stumpf, and Schmid,⁴ in their study on the effect of bicarbonate on the enzymic synthesis of long chain fatty acid by soluble avocado enzyme preparation, reported the stimulation of fat biosynthesis at higher concentration of bicarbonate. They did not observe any incorporation of labeled bicarbonate into either long chain or volatile fatty acid.

Further studies will be conducted to determine whether other substrates, such as glucose, sucrose, acetate, and higher fatty acids, can be possibly used for the preparation of labeled coconut meat.

*C. L. Squires, P. K. Stumpf, and C. Schmid, *Plant Physiology* 33, 365 (1958).

NOTE: THE INFLUENCE OF NITROGEN AND PHOSPHORUS NUTRITION ON THE FLOWERING BEHAVIOR OF RICE

Studies in the U.P. College of Agriculture have shown that the length of the light period or photoperiod markedly affects the time of flowering of most rice varieties (Velasco and Manuel, 1955;¹ Manuel and Velasco, 1957;² Velasco and de la Fuente, 1958³).

Other factors hitherto overlooked may also affect flowering and in fact may superimpose their effect on those of photoperiod. As a part of the general study on the factors of flowering, these experiments were conducted to determine the effects of nitrogen and phosphorus fertilizers on the time it would take rice plants to flower.

Rice of the variety Peta was grown in pots containing subsoil for experiments with nitrogen, and surface soil for studies on phosphorus. The plants were given nitrogen as ammonium sulfate and phosphorus as superphosphate in various combinations and at different stages (tables 1 to 4).

From tables 1 and 2, it may be gathered that 400 to 1,600 kilograms of ammonium sulfate per hectare applied at the time of planting induced the earliest flowering of plants. In other words, there is no prospect of delaying maturity with the range of fertilizer application in commercial rice growing (100 to 400 kg. of ammonium sulfate per hectare). In soil with very low nitrogen, maturity was delayed by about one week (Mistro and Sastri, 1954)⁴. On the other hand, when nitrogen was greatly in excess (8,000 to 12,000 kg. of ammonium sulfate per hectare) there was also a delay of about one week in maturity.

The highest grain yield was obtained with 800 to 1,600 kilos of ammonium sulfate per hectare in the first experiment and with 6,300 to 7,560 kilos per hectare in the second experiment. The seemingly high rates are probably due to the extremely low initial nitrogen in the subsoil and the relatively high amounts of the other essential elements in it.

¹ J. R. Velasco and F. C. Manuel, *Philippine Agriculturist* **39**, 161 (1955).

² F. C. Manuel and J. R. Velasco, *Philippine Agriculturist* **40**, 421 (1957).

³ J. R. Velasco and R. K. de la Fuente, *Philippine Agriculturist* **42**, 12 (1958).

⁴ B. Mistro and S. V. Sastri, *Science* **120** (3111), 277 (1954).

TABLE 1.—*Effect of nitrogen levels on flowering and yield of grains **

N-LEVELS GM. (NH ₄) ₂ SO ₄ PER POT	KG. (NH ₄) ₂ SO ₄ PER HECTARE	DAYS TO FIRST FLOWERING	AVERAGE FLOWERING	GRAIN YIELD (GM.)
Control	0	112.75	118.11	17.11
2.1	200	106.25	113.05	44.65
4.2	400	103.00	109.55	72.60
8.4	800	100.50	105.69	116.00
16.8	1,600	103.75	110.45	116.64

* Planted on November 15, 1957.

TABLE 2.—*Effect of excessive amounts of nitrogen on flowering and yield of grains **

NITROGEN BAULE UNITS ^b	LEVELS KG. (NH ₄) ₂ SO ₄ PER HECTARE	DAYS TO FIRST FLOWERING	AVERAGE FLOWERING	GRAIN YIELD (GM.)
Control	0	113.2	114.55	3.94
½	630	105.8	109.11	27.26
1	1,260	105.4	108.03	73.14
2	2,520	106.2	110.96	248.10
3	3,780	107.0	111.49	292.36
4	6,300	107.8	112.84	323.06
5	7,560	110.4	114.76	320.82
6	8,820	112.0	117.68	287.88
7	10,080	112.4	119.80	266.24
8	11,340	112.6	119.36	233.82
9	12,600	114.6	120.80	214.88

* Planted on June 19, 1958.

^b One Baule unit—252 kg. of an element per hectare.TABLE 3.—*Flower emergence as affected by fertilization of 4.2 g. ammonium sulfate per pot at different stages of growth **

AGE AT FERTILIZATION	FLOWER EMERGENCE (DAYS)	AGE AT FERTILIZATION	FLOWER EMERGENCE (DAYS)
Control	116.0	52	110.7
10	107.7	66	116.7
24	107.2	80	117.2
38	110.0	94	114.2

* Planted on June 15, 1957.

The time of nitrogen application apparently conditions the effect of the fertilizer on "age of flowering." When given later than 66 days of age, it delays flowering (table 3).

TABLE 4.—*Effect of excess nitrogen and phosphorus applied at different times*^a

TIME OF APPLICATION (DAYS)	DAYS TO FIRST FLOWERING		AVERAGE FLOWERING		GRAIN YIELD (GM.)	
	N-P	P	N-P	P	N-P	P
30	116.67	117.0	120.94	120.22	149.73	19.22
50	118.67	115.2	123.55	119.68	144.75	18.70
70	120.50	113.4	124.23	117.23	68.88	15.60

^a Applied with 6,300 kg. $(\text{NH}_4)_2\text{SO}_4$ and 6,471 superphosphate per hectare and planted on June 15, 1958.

Late application of phosphorus (6,471 kilos of superphosphate per hectare) slightly hastened flowering (table 4). However, when phosphorus was combined with nitrogen, late application tended to delay flowering. In terms of grain yield, there was very little benefit derived from phosphorus application.

Various ratios of nitrogen to phosphorus had very little effect on "days to flowering" (table 5). The optimum ionic ratio for flowering was 0.5 of nitrogen to 1.2 of phosphorus. For grain yield, the best was 2.0 of nitrogen to 0 of phosphorus. Apparently, there was adequate native phosphorus in the soil for the needs of the crop.

TABLE 5.—*Effect of different nitrogen to phosphorus ratios on flowering and yield of grains*^a

N-P IONIC RATIOS	EQUIVALENT RATES IN KG. PER HECTARE		DAYS TO FIRST FLOWERING	AVERAGE FLOWERING	GRAIN YIELD (GM.)
	$(\text{NH}_4)_2\text{SO}_4$	SUPER PO_4			
2 : 0	6,300	0	114.00	118.65	250.8
2 : .075	6,300	808.88	112.18	118.05	249.9
2 : .15	6,300	1,617.75	112.18	117.86	247.3
2 : .30	6,300	3,235.50	111.50	116.34	245.3
2 : .60	6,300	6,471.00	110.50	116.96	247.6
1 : 1.2	3,150	6,471.00	109.75	113.23	203.7
.5 : 1.2	1,575	6,471.00	108.50	112.65	156.6
0 : 1.2	0	6,471.00	112.25	114.54	17.8

^a Planted on June 19, 1958.

—ERNESTO B. PANTASTICO

NOTE: ASCORBIC ACID CONTENTS OF SOME PHILIPPINE FRUITS

Ascorbic acid or vitamin C is a very important vitamin. Its deficiency in the diet causes scurvy. The more important sources of ascorbic acid are citrus fruits, tomatoes, leafy vegetables, and potatoes. The Institute of Nutrition had published analyses of some fruits for ascorbic acid by the colorimetric method.¹ In this work, the ascorbic acid content of some Philippine fruits was determined following the ferricyanometric method of Sant.² Results of the analyses are presented in table 1.

TABLE 1.—Ascorbic acid contents of the edible portion of some Philippine fruits

SAMPLE	ASCORBIC ACID
	mg./100 g. ^a
Aserola (<i>Malpighia glabra</i> L.)	
Red color	1,468
Purple	1,528
Orange	1,549
Green	3,178
Balimbing (<i>Averrhoa carambola</i> L.)	
Ripe (sour variety)	26
Green (sour variety)	33
Banana (<i>Musa sapientum</i> L.)	
Bungulan, big variety	103
Latundan, big variety	56
Latundan, small variety	16
Lakatan, small variety	60
Banana (<i>Musa paradisiaca</i> L.)	
Saba, white flesh	33
Chico (<i>Achras zapota</i> L.)	
Native	103
Dalandan (<i>Citrus nobilis</i> Lour.)	
King Mandarin	21
Dalanghita China (<i>Citrus aurantium</i> L.)	
Szimkom mandarin	33

^a Based on grams of fresh edible portions.

¹ Institute of Nutrition Handbook I (revised, 1957).

² B. R. Sant, *Chem. Analyst* 47 (1958).

TABLE 1 (continued)

SAMPLE	ASCORBIC ACID
	mg./100 g. ^a
Guava (<i>Psidium guajava</i> L.)	
White flesh	27
Pink flesh	368
Guayabano (<i>Anona muricata</i> L.)	
Sweet variety	38
Kalamansi (<i>Citrus microcarpa</i> Bunge)	
Green	57
Yellow	43
Kamias (<i>Averrhoa bilimbi</i> L.)	8
Lansones (<i>Lansium domesticum</i> Correa)	
Sweet variety	22
Pasionarya (<i>Passiflora edulis</i> Sims)	
Small and sour	119
Pasionarya (<i>Passiflora quadrangularis</i> L.)	
Big and sweet	145
Rambutan III (<i>Nephelium lappaceum</i> L.)	
Usau	184
Santol [<i>Sandoricum koetjape</i> (Burm. f.) Merr.]	
Big and fleshy	355
Siniguelas (<i>Spondias mombin</i> L.)	
Yellow and sour variety	59

^a Based on grams of fresh edible portions.

Of the fruits analyzed, the aserola (barbados cherry) had the highest amount of ascorbic acid, followed by santol, rambutan III, the pink guava, the pasionarya, and chico fruits.

—MAMERTA M. YLAGAN

THE CENTRAL EXPERIMENT STATION

LIST OF AVAILABLE PUBLICATIONS

BOOKS:

Volume I—Field Crops	P12.00
Volume II—Livestock and Poultry	7.90
Postage	.40

CENTRAL EXPERIMENT STATION BULLETIN:

No. 1—Farm Management, Land Use and Tenancy in the Philippines— <i>By Horst von Oppenfeld, J. C. Sta. Iglesia, P. R. Sandoval</i>	P1.00
---	-------

CIRCULARS:

No. 1—Perennials in the Arboretum of the College of Agriculture and Vicinity— <i>By J. V. Pancho and G. C. Lugod</i>	0.45
No. 33—Kenaf Culture— <i>By P. A. David</i>	.30
No. 34—Vanilla Culture— <i>By P. A. David</i>	.30
No. 35—Black Pepper Culture— <i>By P. A. David</i>	.30

TECHNICAL BULLETINS:

No. 2—Guide to Certified Rice Seed Production	.40
No. 3—Guide to Certified Hybrid Seed Corn Production	.40
No. 4—Common Diseases of Vegetable Crops and Their Control on the Philippines	.70
No. 5—Mushroom culture	.25
No. 6—Swine Raising for Beginners	.40

All orders for books with remittance should be addressed to

THE DEAN AND DIRECTOR
COLLEGE OF AGRICULTURE AND
CENTRAL EXPERIMENT STATION
COLLEGE, LAGUNA, PHILIPPINES

The Philippine Agriculturist

(Formerly The Philippine Agriculturist and Forester)

Published by the COLLEGE OF AGRICULTURE
AND CENTRAL EXPERIMENT STATION
UNIVERSITY OF THE PHILIPPINES

Vol. I—2	Vol. XXIV—Complete
Vol. II—4-6	Vol. XXV—Complete
Vol. IV—3, 5-6, 7	Vol. XXVI—Complete
Vol. V—5, 6, 8, 9, 10	Vol. XXVII—Complete
Vol. VI—1, 4, 5-6, 7, 8, 9, 10	Vol. XXXI—1, 2, 3, 4
Vol. VII—1, 2, 3, 4, 5, 7, 8	Vol. XXXII—1, 2, 3, 4
Vol. VIII—3, 4, 5, 7, 8-9, 10	Vol. XXXIII—1, 2, 3, 4
Vol. IX—3, 4-5	Vol. XXXIV—2, 4
Vol. XI—8	Vol. XXXV—Complete
Vol. XIII—3, 5, 6, 9, 10	Vol. XXXVI—1, 2, 4, 5, 6, 7, 8, 9, 10
Vol. XIV—1, 2, 3, 4, 5, 6, 7, 9	Vol. XXXVII—1-2, 4, 5-6, 7, 8, 9, 10
Vol. XV—Complete	Vol. XXXVIII—1, 2-3, 4-5, 6-7, 8
Vol. XVI—7, 8, 9	Vol. XXXIX—1, 2, 5, 6, 7, 8, 9, 10
Vol. XVII—6, 7, 8, 9, 10	Vol. XL—Complete
Vol. XVIII—Complete	Vol. XLI—Complete
Vol. XIX—Complete	Vol. XLII—Complete
Vol. XX—Complete	Vol. XLIII—Complete
Vol. XXI—Complete	
Vol. XXII—Complete	
Vol. XXIII—1, 2, 3, 4, 6, 7, 8, 9, 10	

Back copies of Vols. I to XXVII sell at 50 centavos a copy and back copies of Vols. XXXI to XXXIX sell at ₱1.50 a copy.

Send your order to the BUSINESS MANAGER, THE PHILIPPINE AGRICULTURIST, COLLEGE, LAGUNA, PHILIPPINES.